REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-00-

~~0256~~ 0775

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT
	December, 1997	

4. TITLE AND SUBTITLE
1997 Summer Research Program (SRP), High School Apprenticeship Program (HSAP), Final Reports, Volume 16, Arnold Engineering Development Center

5. FUNDING NUMBERS
F49620-93-C-0063

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Office of Scientific Research (AFOSR)
801 N. Randolph St.
Arlington, VA 22203-1977

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for Public Release

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members (Summer Faculty Research Program, (SFRP)), graduate students (Graduate Student Research Program (GSRP)), and high school students (High School Apprenticeship Program (HSAP)) being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates, Air Force Air Logistics Centers (ALC), and other AF Laboratories. This volume consists of a program overview, program management statistics, and the final technical reports from the HSAP participants at the Arnold Engineering Development Center.

14. SUBJECT TERMS
Air Force Research, Air Force, Engineering, Laboratories, Reports, Summer, Universities, Faculty, Graduate Student, High School Student

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1997

HIGH SCHOOL APPRENTICESHIP PROGRAM FINAL REPORTS

VOLUME 16

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AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Bolling Air Force Base

Washington, D.C.

December 1997

PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

This document is one of a set of 16 volumes describing the 1997 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2A & 2B	Armstrong Laboratory
3A & 3B	Phillips Laboratory
4A & 4B	Rome Laboratory
5A , 5B & 5C	Wright Laboratory
6	Arnold Engineering Development Center, United States Air Force Academy and Air Logistics Centers
	Graduate Student Research Program (GSRP) Reports
7A & 7B	Armstrong Laboratory
8	Phillips Laboratory
9	Rome Laboratory
10A & 10B	Wright Laboratory
11	Arnold Engineering Development Center, United States Air Force Academy, Wilford Hall Medical Center and Air Logistics Centers
	High School Apprenticeship Program (HSAP) Reports
12A & 12B	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
15A, 15B & 15C	Wright Laboratory
16	Arnold Engineering Development Center

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Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years. Since then, the number of funded positions has remained fairly constant at a slightly lower level.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 52-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous individual requesters (over 1000 annually).

RDL placed advertisements in the following publications: *Black Issues in Higher Education, Winds of Change,* and *IEEE Spectrum.* Because no participants list either *Physics Today* or *Chemical & Engineering News* as being their source of learning about the program for the past several years, advertisements in these magazines were dropped, and the funds were used to cover increases in brochure printing costs.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1997 are shown in this table.

1997 Applicants and Participants			
PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP	490	188	32
(HBCU/MI)	(0)	(0)	(0)
GSRP	202	98	9
(HBCU/MI)	(0)	(0)	(0)
HSAP	433	140	14
TOTAL	1125	426	55

4. SITE VISITS

During June and July of 1997, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

Before 1993, an RDL program representative visited from seven to ten different HBCU/MIs annually to promote interest in the SRP among the faculty and graduate students. These efforts were marginally effective, yielding a doubling of HBCI/MI applicants. In an effort to achieve AFOSR's goal of 10% of all applicants and selectees being HBCU/MI qualified, the RDL team decided to try other avenues of approach to increase the number of qualified applicants. Through the combined efforts of the AFOSR Program Office at Bolling AFB and RDL, two very active minority groups were found, HACU (Hispanic American Colleges and Universities) and AISES (American Indian Science and Engineering Society). RDL is in communication with representatives of each of these organizations on a monthly basis to keep up with the their activities and special events. Both organizations have widely-distributed magazines/quarterlies in which RDL placed ads.

Since 1994 the number of both SFRP and GSRP HBCU/MI applicants and participants has increased ten-fold, from about two dozen SFRP applicants and a half dozen selectees to over 100 applicants and two dozen selectees, and a half-dozen GSRP applicants and two or three selectees to 18 applicants and 7 or 8 selectees. Since 1993, the SFRP had a two-fold applicant increase and a two-fold selectee increase. Since 1993, the GSRP had a three-fold applicant increase and a three to four-fold increase in selectees.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates. This year, 5 HBCU/MI SFRPs declined after they were selected (and there was no one qualified to replace them with). The following table records HBCU/MI participation in this program.

SRP HBCU/MI Participation, By Year				
YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6
1995	90	21	20	8
1996	119	27	18	7

6. SRP FUNDING SOURCES

Funding sources for the 1997 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1997 SRP selected participants are shown here.

1997 SRP FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	141	89	123
USAF Laboratory Funds	48	9	17
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	0	0	N/A
TOTAL	9	98	140

SFRP - 188 were selected, but thirty two canceled too late to be replaced.
GSRP - 98 were selected, but nine canceled too late to be replaced.
HSAP - 140 were selected, but fourteen canceled too late to be replaced.

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

1997 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994	1995	1996	1997
Faculty Members	$690	$718	$740	$740	$740	$770	$770
Graduate Student (Master's Degree)	$425	$442	$455	$455	$455	$470	$470
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391	$391	$400	$400
High School Student (First Year)	$200	$200	$200	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $50/day for faculty and $40/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 65 % (194 out of 286) claimed travel reimbursements at an average round-trip cost of $776.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-three percent (85 out of 188) of faculty associates took orientation trips at an average cost of $388. By contrast, in 1993, 58 % of SFRP associates took

orientation visits at an average cost of $685; that was the highest percentage of associates opting to take an orientation trip since RDL has administered the SRP, and the highest average cost of an orientation trip. These 1993 numbers are included to show the fluctuation which can occur in these numbers for planning purposes.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

This is the second year of using direct deposit for the SFRP and GSRP associates. The process went much more smoothly with respect to obtaining required information from the associates, only 7% of the associates' information needed clarification in order for direct deposit to properly function as opposed to 10% from last year. The remaining associates received their stipend and expense payments via checks sent in the US mail.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1997 REPORT

The complete set of reports for the 1997 SRP includes this program management report (Volume 1) augmented by fifteen volumes of final research reports by the 1997 associates, as indicated below:

1997 SRP Final Report Volume Assignments

LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, ALCs, WHMC	6	11	16

APPENDIX A – PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP associates represented 169 different colleges, universities, and institutions, GSRP associates represented 95 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 47 states plus Washington D.C. Selectees represent 44 states.

GSRP - Applicants came from 44 states. Selectees represent 32 states.

HSAP - Applicants came from thirteen states. Selectees represent nine states.

Total Number of Participants	
SFRP	189
GSRP	97
HSAP	140
TOTAL	426

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	184	0	184
Master's	2	41	43
Bachelor's	0	56	56
TOTAL	186	97	298

SFRP Academic Titles	
Assistant Professor	64
Associate Professor	70
Professor	40
Instructor	0
Chairman	1
Visiting Professor	1
Visiting Assoc. Prof.	1
Research Associate	9
TOTAL	186

Source of Learning About the SRP		
Category	Applicants	Selectees
Applied/participated in prior years	28%	34%
Colleague familiar with SRP	19%	16%
Brochure mailed to institution	23%	17%
Contact with Air Force laboratory	17%	23%
IEEE Spectrum	2%	1%
BIIHE	1%	1%
Other source	10%	8%
TOTAL	100%	100%

APPENDIX B -- SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	275
HSAPs	113
USAF Laboratory Focal Points	84
USAF Laboratory HSAP Mentors	6

All groups indicate unanimous enthusiasm for the SRP experience.

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below:

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Faculty Associates suggest higher stipends for SFRP associates.

C. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same argument was used to raise the faculty and graduate student participation time a few years ago.)

2. 1997 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 84 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ?								(% Response)			
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	Evals Recv'd	0	1	2	3+	0	1	2	3+	0	1	2	3+
AEDC	0	-	-	-	-	-	-	-	-	-	-	-	-
WHMC	0	-	-	-	-	-	-	-	-	-	-	-	-
AL	7	28	28	28	14	54	14	28	0	86	0	14	0
USAFA	1	0	100	0	0	100	0	0	0	0	100	0	0
PL	25	40	40	16	4	88	12	0	0	84	12	4	0
RL	5	60	40	0	0	80	10	0	0	100	0	0	0
WL	46	30	43	20	6	78	17	4	0	93	4	2	0
Total	84	32%	50%	13%	5%	80%	11%	6%	0%	73%	23%	4%	0%

LFP Evaluation Summary. The summarized responses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5. a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:

13. a. Quality of RDL's communications with you:

b. Quality of RDL's communications with associates:

14. Overall assessment of SRP:

Table B-3. Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*USAFA*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	0	7	1	14	5	0	46
Question #							
2	-	86 %	0 %	88 %	80 %	-	85 %
2a	-	4.3	n/a	3.8	4.0	-	3.6
2b	-	4.0	n/a	3.9	4.5	-	4.1
3	-	4.5	n/a	4.3	4.3	-	3.7
4	-	4.1	4.0	4.1	4.2	-	3.9
5a	-	4.3	5.0	4.3	4.6	-	4.4
5b	-	4.5	n/a	4.2	4.6	-	4.3
6a	-	4.5	5.0	4.0	4.4	-	4.3
6b	-	4.3	n/a	4.1	5.0	-	4.4
6c	-	3.7	5.0	3.5	5.0	-	4.3
7a	-	4.7	5.0	4.0	4.4	-	4.3
7b	-	4.3	n/a	4.2	5.0	-	4.4
7c	-	4.0	5.0	3.9	5.0	-	4.3
8	-	4.6	4.0	4.5	4.6	-	4.3
9	-	4.9	5.0	4.4	4.8	-	4.2
10a	-	5.0	n/a	4.6	4.6	-	4.6
10b	-	4.7	5.0	3.9	5.0	-	4.4
11	-	4.6	5.0	4.4	4.8	-	4.4
12	-	4.0	4.0	4.0	4.2	-	3.8
13a	-	3.2	4.0	3.5	3.8	-	3.4
13b	-	3.4	4.0	3.6	4.5	-	3.6
14	-	4.4	5.0	4.4	4.8	-	4.4

3. 1997 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 257 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from 1 (below average) to 5 (above average) - by Air Force base results and over-all results of the 1997 evaluations are listed after the questions.

1. The match between the laboratories research and your field:
2. Your working relationship with your LFP:
3. Enhancement of your academic qualifications:
4. Enhancement of your research qualifications:
5. Lab readiness for you: LFP, task, plan:
6. Lab readiness for you: equipment, supplies, facilities:
7. Lab resources:
8. Lab research and administrative support:
9. Adequacy of brochure and associate handbook:
10. RDL communications with you:
11. Overall payment procedures:
12. Overall assessment of the SRP:
13. a. Would you apply again?
    b. Will you continue this or related research?
14. Was length of your tour satisfactory?
15. Percentage of associates who experienced difficulties in finding housing:
16. Where did you stay during your SRP tour?
    a. At Home:
    b. With Friend:
    c. On Local Economy:
    d. Base Quarters:
17. Value of orientation visit:
    a. Essential:
    b. Convenient:
    c. Not Worth Cost:
    d. Not Used:

SFRP and GSRP associate's responses are listed in tabular format on the following page.

Table B-4. 1997 SFRP & GSRP Associate Responses to SRP Evaluation

	Arnold	Brooks	Edwards	Eglin	Griffis	Hanscom	Kelly	Kirtland	Lackland	Robins	Tyndall	WPAFB	average
# res	6	48	6	14	31	19	3	32	1	2	10	85	257
1	4.8	4.4	4.6	4.7	4.4	4.9	4.6	4.6	5.0	5.0	4.0	4.7	4.6
2	5.0	4.6	4.1	4.9	4.7	4.7	5.0	4.7	5.0	5.0	4.6	4.8	4.7
3	4.5	4.4	4.0	4.6	4.3	4.2	4.3	4.4	5.0	5.0	4.5	4.3	4.4
4	4.3	4.5	3.8	4.6	4.4	4.4	4.3	4.6	5.0	4.0	4.4	4.5	4.5
5	4.5	4.3	3.3	4.8	4.4	4.5	4.3	4.2	5.0	5.0	3.9	4.4	4.4
6	4.3	4.3	3.7	4.7	4.4	4.5	4.0	3.8	5.0	5.0	3.8	4.2	4.2
7	4.5	4.4	4.2	4.8	4.5	4.3	4.3	4.1	5.0	5.0	4.3	4.3	4.4
8	4.5	4.6	3.0	4.9	4.4	4.3	4.3	4.5	5.0	5.0	4.7	4.5	4.5
9	4.7	4.5	4.7	4.5	4.3	4.5	4.7	4.3	5.0	5.0	4.1	4.5	4.5
10	4.2	4.4	4.7	4.4	4.1	4.1	4.0	4.2	5.0	4.5	3.6	4.4	4.3
11	3.8	4.1	4.5	4.0	3.9	4.1	4.0	4.0	3.0	4.0	3.7	4.0	4.0
12	5.7	4.7	4.3	4.9	4.5	4.9	4.7	4.6	5.0	4.5	4.6	4.5	4.6
Numbers below are percentages													
13a	83	90	83	93	87	75	100	81	100	100	100	86	87
13b	100	89	83	100	94	98	100	94	100	100	100	94	93
14	83	96	100	90	87	80	100	92	100	100	70	84	88
15	17	6	0	33	20	76	33	25	0	100	20	8	39
16a	-	26	17	9	38	23	33	4	-	-	-	30	
16b	100	33	-	40	-	8	-	-	-	-	36	2	
16c	-	41	83	40	62	69	67	96	100	100	64	68	
16d	-	-	-	-	-	-	-	-	-	-	-	0	
17a	-	33	100	17	50	14	67	39	-	50	40	31	35
17b	-	21	-	17	10	14	-	24	-	50	20	16	16
17c	-	-	-	-	10	7	-	-	-	-	-	2	3
17d	100	46	-	66	30	69	33	37	100	-	40	51	46

4. 1997 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

Not enough evaluations received (5 total) from Mentors to do useful summary.

5. 1997 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 113 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from 1 (below average) to 5 (above average)

1. Your influence on selection of topic/type of work.
2. Working relationship with mentor, other lab scientists.
3. Enhancement of your academic qualifications.
4. Technically challenging work.
5. Lab readiness for you: mentor, task, work plan, equipment.
6. Influence on your career.
7. Increased interest in math/science.
8. Lab research & administrative support.
9. Adequacy of RDL's Apprentice Handbook and administrative materials.
10. Responsiveness of RDL communications.
11. Overall payment procedures.
12. Overall assessment of SRP value to you.
13. Would you apply again next year? Yes (92 %)
14. Will you pursue future studies related to this research? Yes (68 %)
15. Was Tour length satisfactory? Yes (82 %)

	Arnold	Brooks	Edwards	Eglin	Griffiss	Hanscom	Kirtland	Tyndall	WPAFB	Totals
# resp	5	19	7	15	13	2	7	5	40	113
1	2.8	3.3	3.4	3.5	3.4	4.0	3.2	3.6	3.6	3.4
2	4.4	4.6	4.5	4.8	4.6	4.0	4.4	4.0	4.6	4.6
3	4.0	4.2	4.1	4.3	4.5	5.0	4.3	4.6	4.4	4.4
4	3.6	3.9	4.0	4.5	4.2	5.0	4.6	3.8	4.3	4.2
5	4.4	4.1	3.7	4.5	4.1	3.0	3.9	3.6	3.9	4.0
6	3.2	3.6	3.6	4.1	3.8	5.0	3.3	3.8	3.6	3.7
7	2.8	4.1	4.0	3.9	3.9	5.0	3.6	4.0	4.0	3.9
8	3.8	4.1	4.0	4.3	4.0	4.0	4.3	3.8	4.3	4.2
9	4.4	3.6	4.1	4.1	3.5	4.0	3.9	4.0	3.7	3.8
10	4.0	3.8	4.1	3.7	4.1	4.0	3.9	2.4	3.8	3.8
11	4.2	4.2	3.7	3.9	3.8	3.0	3.7	2.6	3.7	3.8
12	4.0	4.5	4.9	4.6	4.6	5.0	4.6	4.2	4.3	4.5
Numbers below are percentages										
13	60%	95%	100%	100%	85%	100%	100%	100%	90%	92%
14	20%	80%	71%	80%	54%	100%	71%	80%	65%	68%
15	100%	70%	71%	100%	100%	50%	86%	60%	80%	82%

A MATH MODEL OF THE FLOW CHARACTERISTICS OF THE J4 GASEOUS NITROGEN REPRESS SYSTEMS

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Final Report for:
High School Apprentice Program
Arnolds Air Force Base, TN

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

The J4 Rocket Test Team

August 1997

A MATH MODEL OF THE FLOW CHARACTERISTICS OF THE J4 GASEOUS NITROGEN REPRESS SYSTEMS

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Abstract

A mathematical model of the J4 repress system was created using a modified form of Bernoulli's Theorem. The system was walked down and each component was measured. Then those units were changed into a universal coefficient which was implemented into the theorem. Using this model several graphs can be plotted. Graphs can even be plotted for different percentages the control valve is opened. In this case, flow rate duration and minimum supply pressure were plotted for set flow rates. This information is useful for the test conductor in selecting the test schedule and setting conditions at engine shutdown for cell purging and cell repressurization.

A MATH MODEL OF THE FLOW CHARACTERISTICS OF
THE J4 GASEOUS NITROGEN REPRESS SYSTEMS

Karllee Barton
Coffee County Central High School

Introduction

Mathematical models are useful in describing physical characteristics of technical systems used in mechanical engineering. I, with the guiding hand of my mentor, Dr. McAmis created such a mathematical model to describe the characteristics of the repressurization system of the J4 Rocket Propoltion Test Facility. This model describes characteristics, such as the minimum supply pressure and the duration of flow, which are necessary to the facility's ability to test.

The test facility uses a nitrogen repressurization system for two reasons: One. The repress system repressurizes the low pressure test cell to prevent blow back from the high pressure spray chamber. Two. The gaseous nitrogen in the system will inert the cell from any hydrogen buildup that may occur during a test cession. A certain flow rate of nitrogen must be set and maintained to achieve these two goals. Using data obtained from this model the test conductor, currently Bob Truesdale, can safely set supply pressure and calculate duration of flow for a pre-set nitrogen flow rate.

Discussing the Problem

The main problem with the repress system is calculating the minimum supply pressure and duration of the that pressure at a set flow rate. However, these characteristics are extremely important in

determining the capabilities of the facility. Safety for both the test cell and rocket being tested rests on the capability of the repress system to inert and repressurize the cell.

Methodology

The first action taken was to use the Crane Handbook [1] to find a formula that could be used to calculate the desired characteristic. A modified form of Bernoulli's Theorem was found to fit the situation perfectly. The derived equation shows that the flow rate equals 0.525 times the net expansion factor for compressible flow though orifices, nozzles, or pipe times the inside diameter of the pipe squared times the square root of the change in pressure divided by the square root of the friction coefficient and the specific volume of the gas $\{w=0.525Yd^2\sqrt{(\Delta P/KV)}\}$.

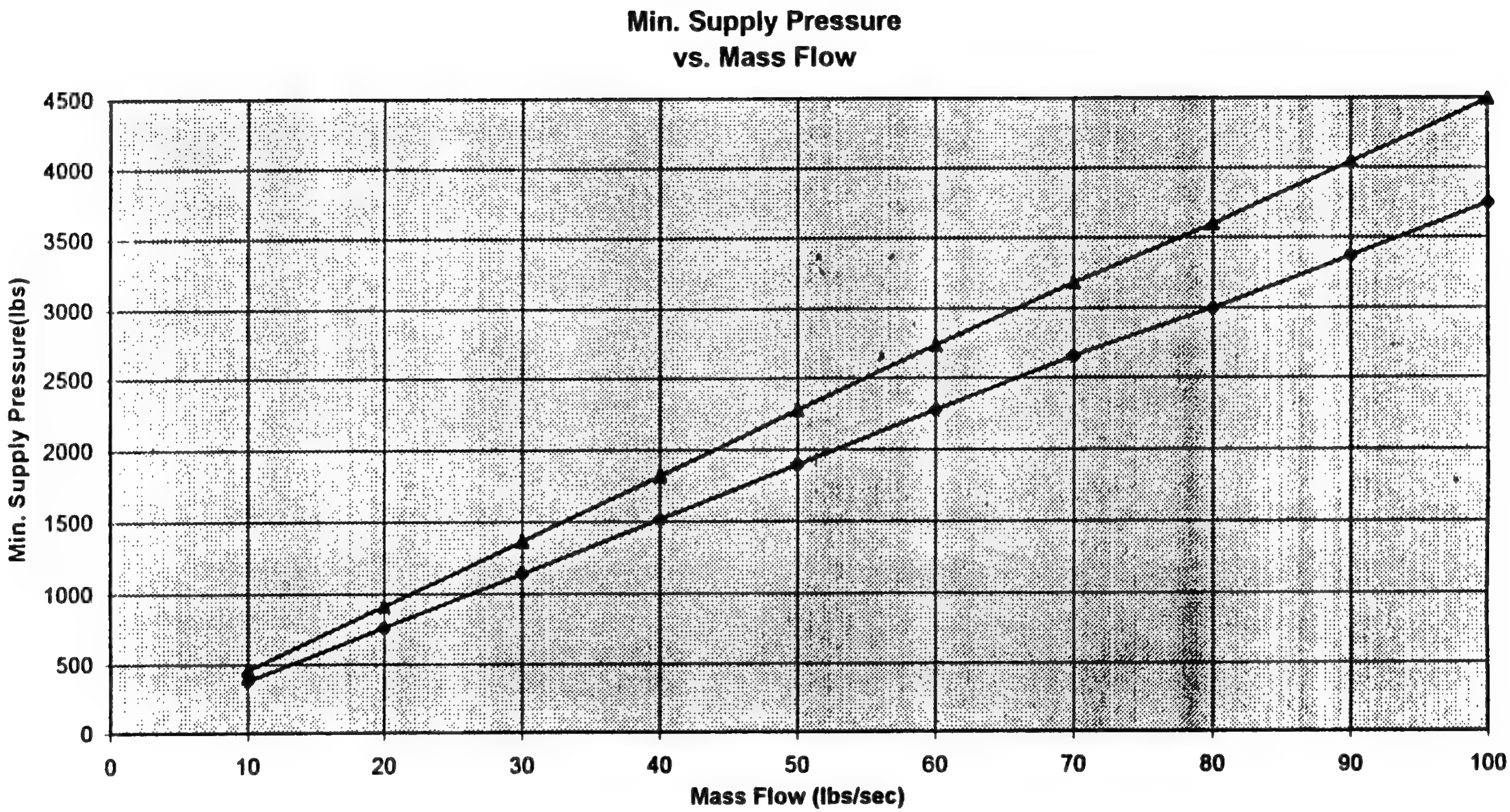
The physical properties of the system were need in the creation of the model. The system was physically walk down and measured. With those measurements two diagrams were made. The first contains the physical dimensions of the internal systems of the repress system (Appendix A). The second contains the physical dimensions of the pipe that connect the internal systems(Appendix B). Using an Excel spreadsheet (Appendix C), the universal friction coefficients, K factors, of the different sizes of pipe were derived from those dimensions and added together to calculate the total K factor. Then using the Ideal Gas Law ($\Delta PV/RT$) and the Crane Handbook the empirical variables were defined. The spreadsheet then incorporated the data to synthesize graphs of the minimum supply pressures and flow duration curves at separate control valve settings.

Results

One result of the data from the mathematical model showed the minimum supply pressure and a

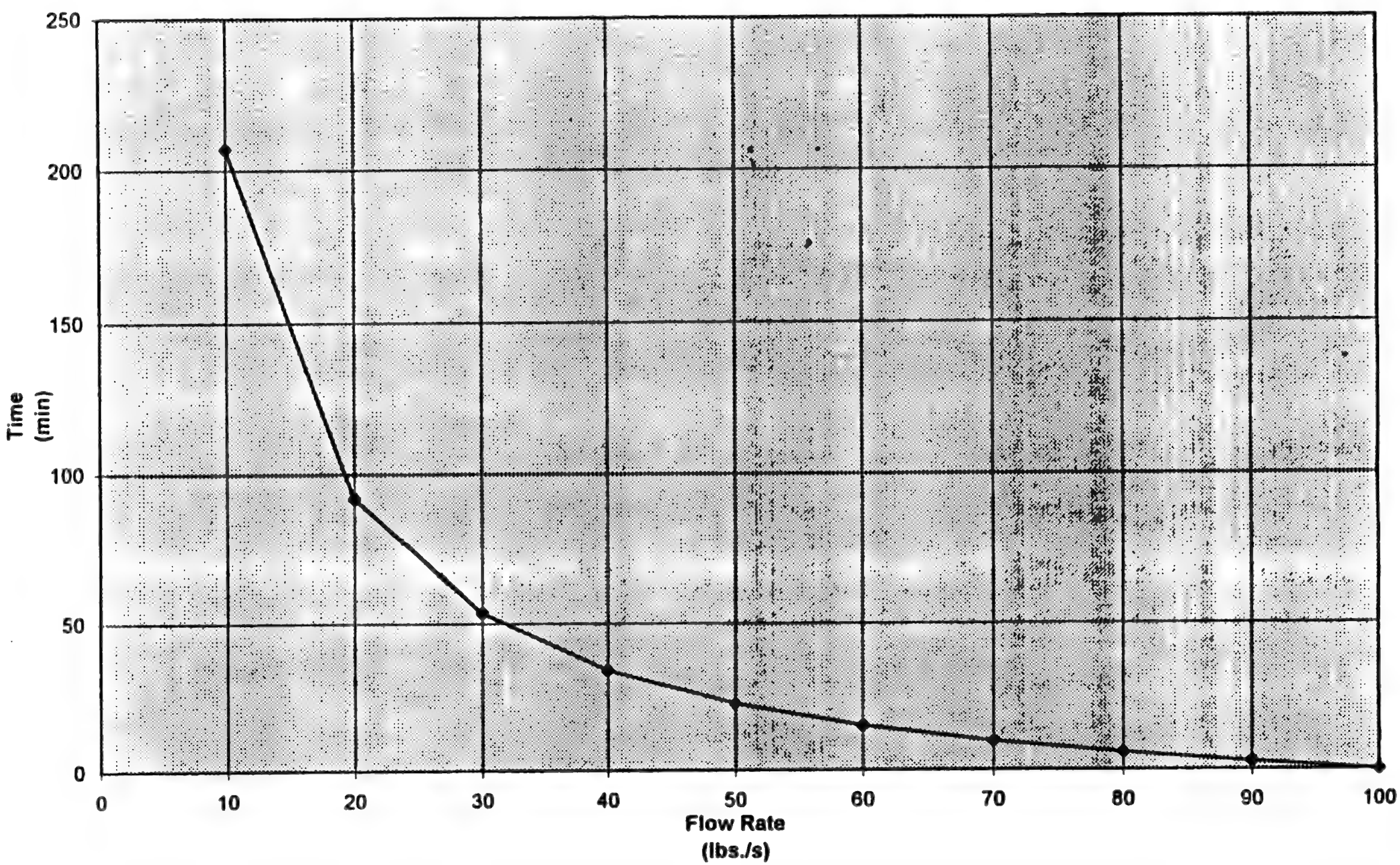
twenty percent safety margin in contrast to the required flow rate set to a standard deviation of ten lbs. per sec. Another result is the duration that the set flow rate can be maintained. The graphs that follow show the data stated with the control valve at 100%, 90%, and 80% open.

100%

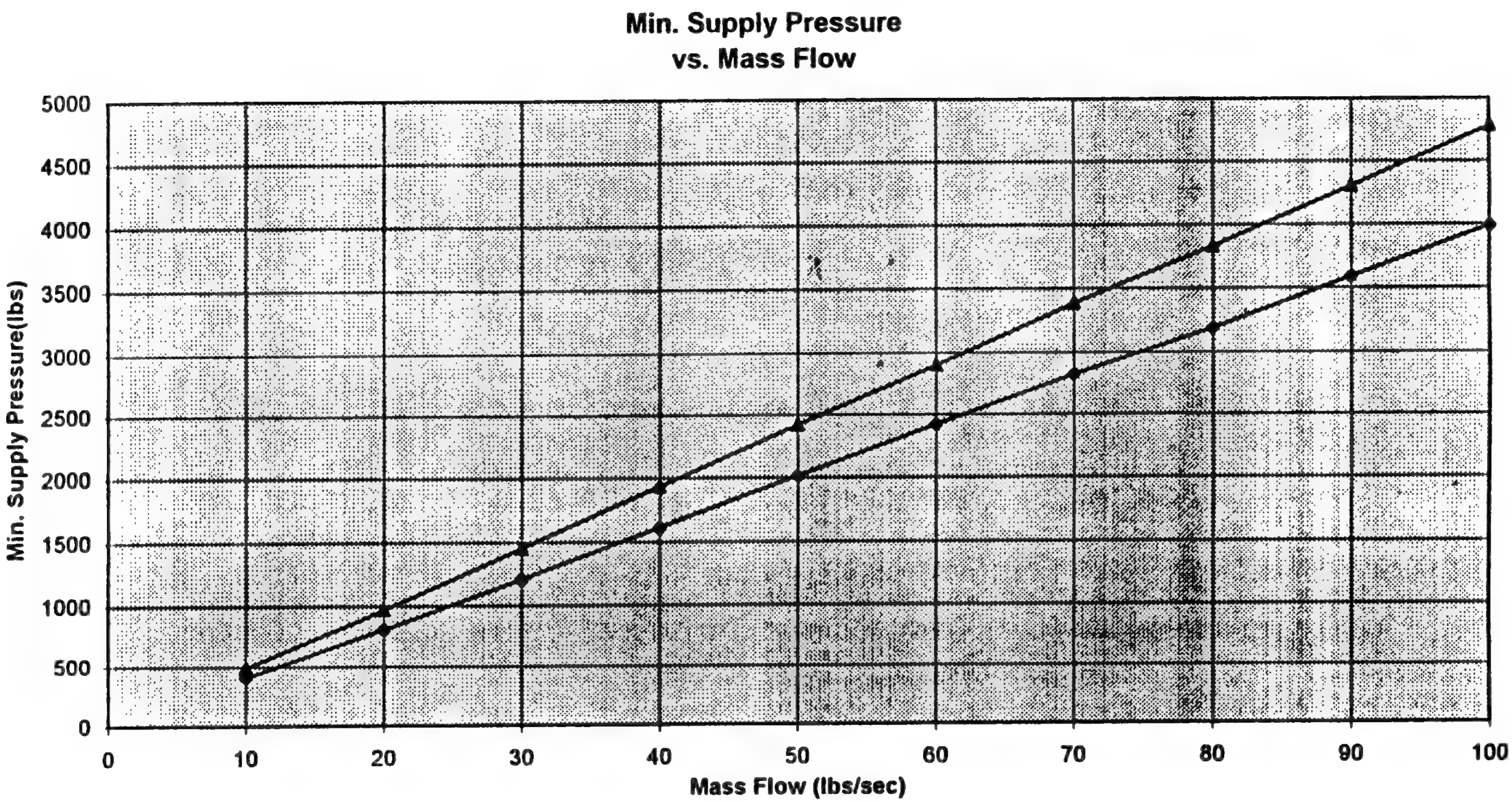

Min. Supply Pressure
vs. Mass Flow
Min. Supply Pressure(lbs)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Mass Flow (lbs/sec)

100%

Duration Chart



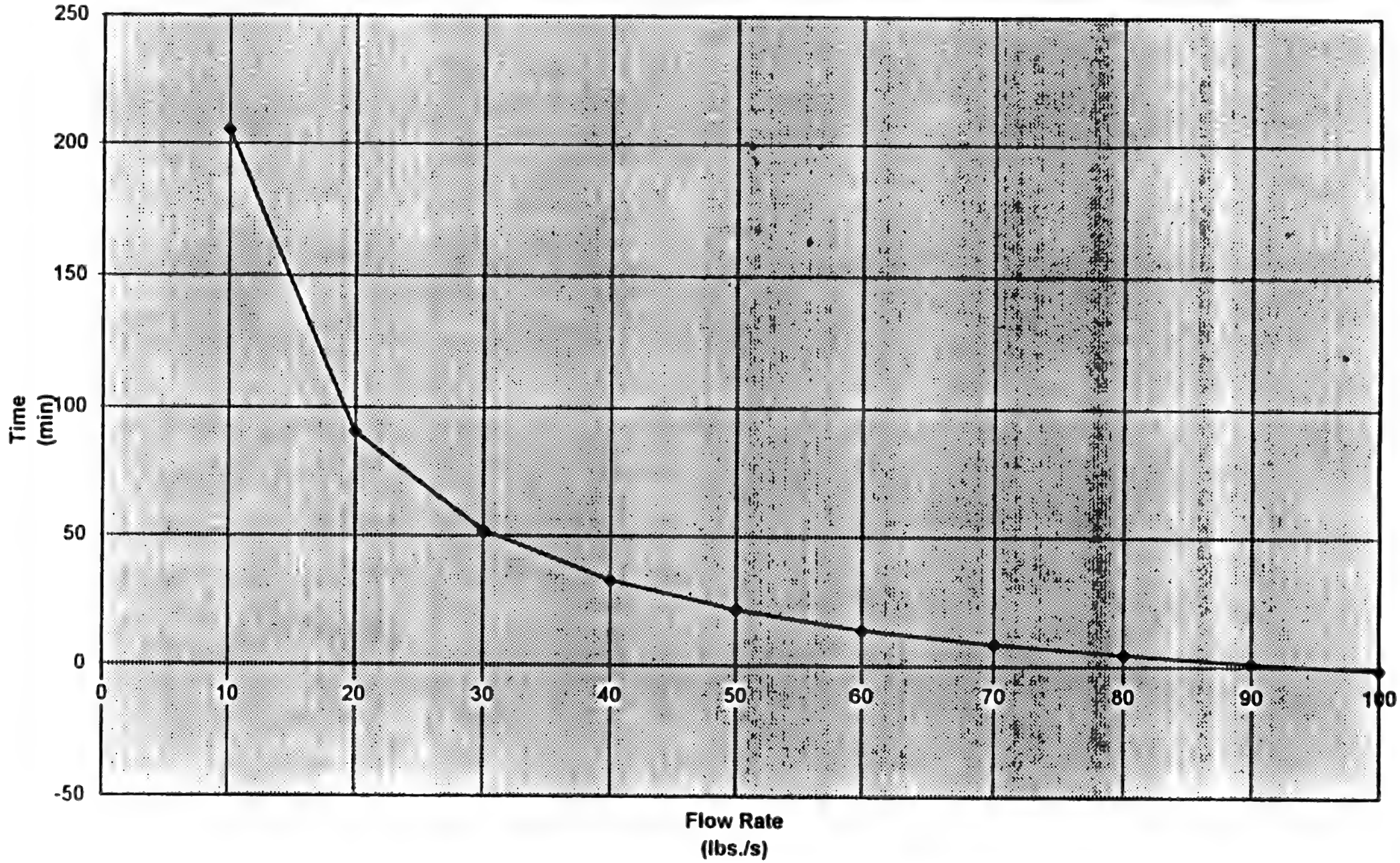
90%

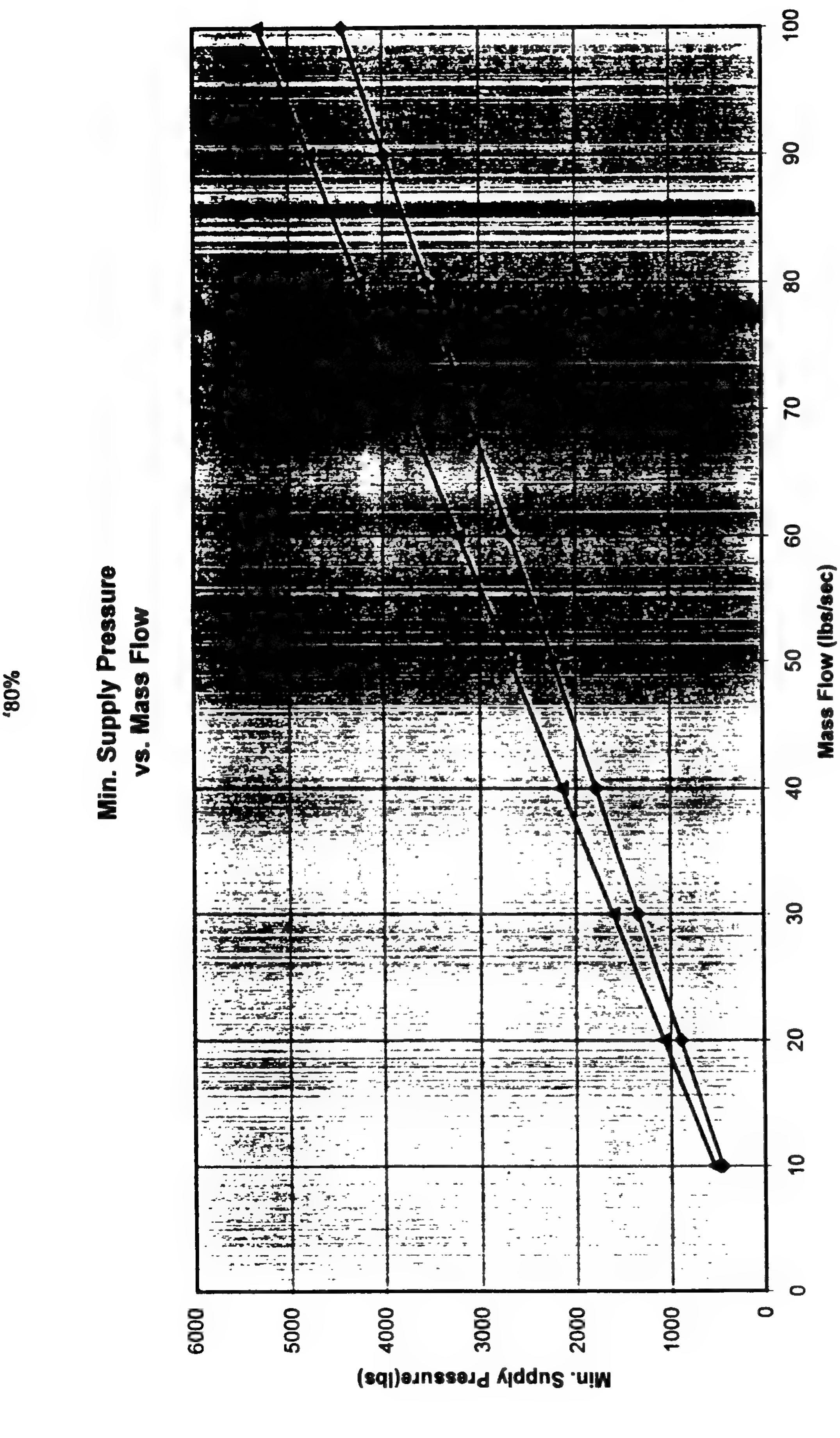


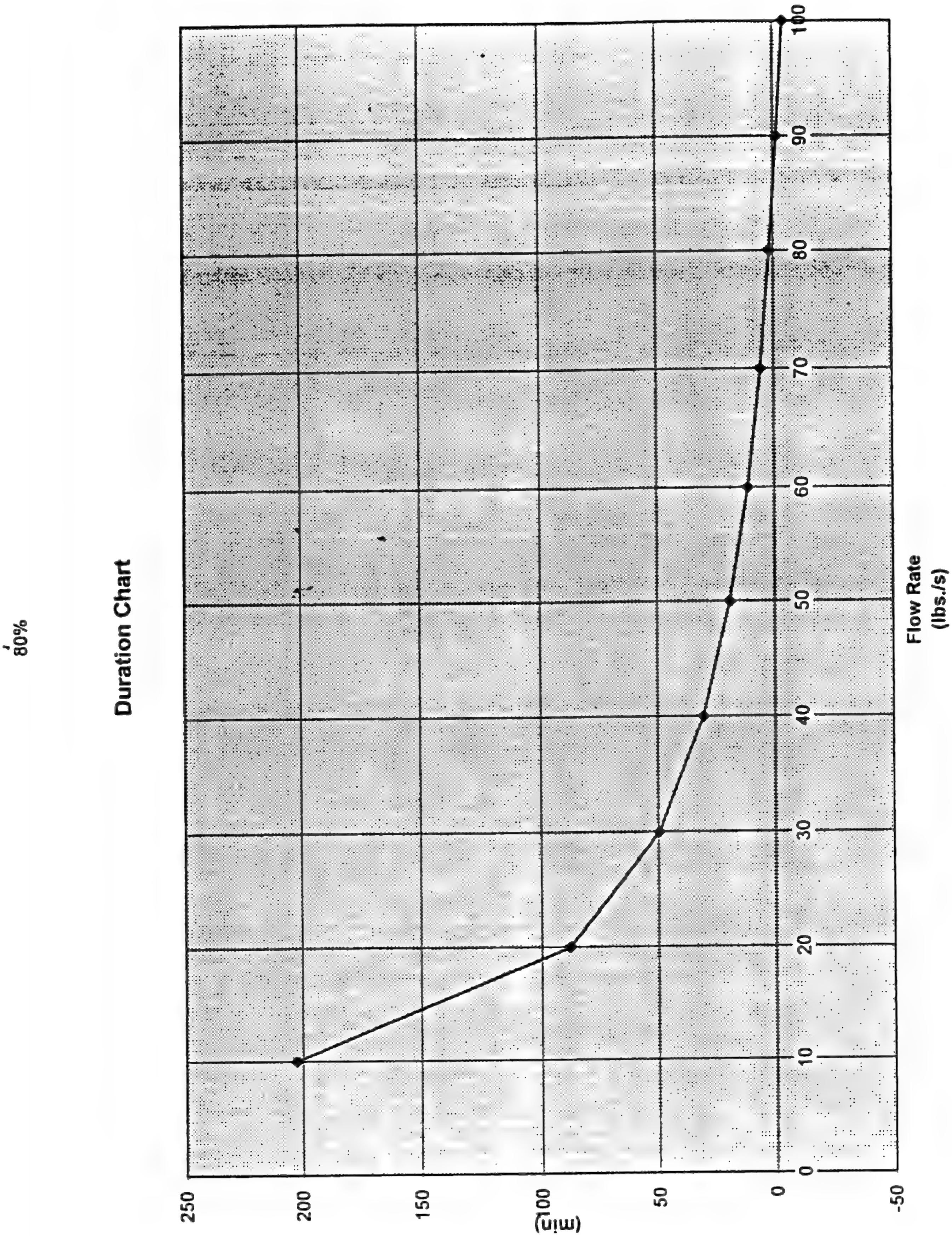
Min. Supply Pressure
vs. Mass Flow
Min. Supply Pressure(lbs)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Mass Flow (lbs/sec)

90%

Duration Chart




'80%
Min. Supply Pressure
vs. Mass Flow
Min. Supply Pressure(lbs)
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
100
Mass Flow (lbs/sec)

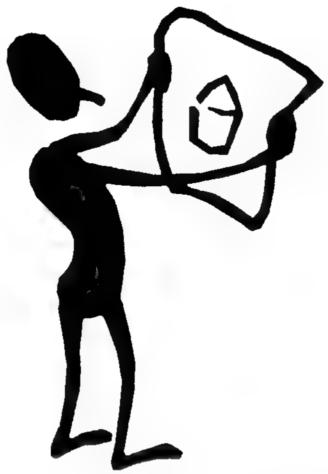

80%
Duration Chart
Time
(min)
250
200
150
100
50
0
-50
0
10
20
30
40
50
60
70
80
90
100
Flow Rate
(lbs./s)

Conclusion

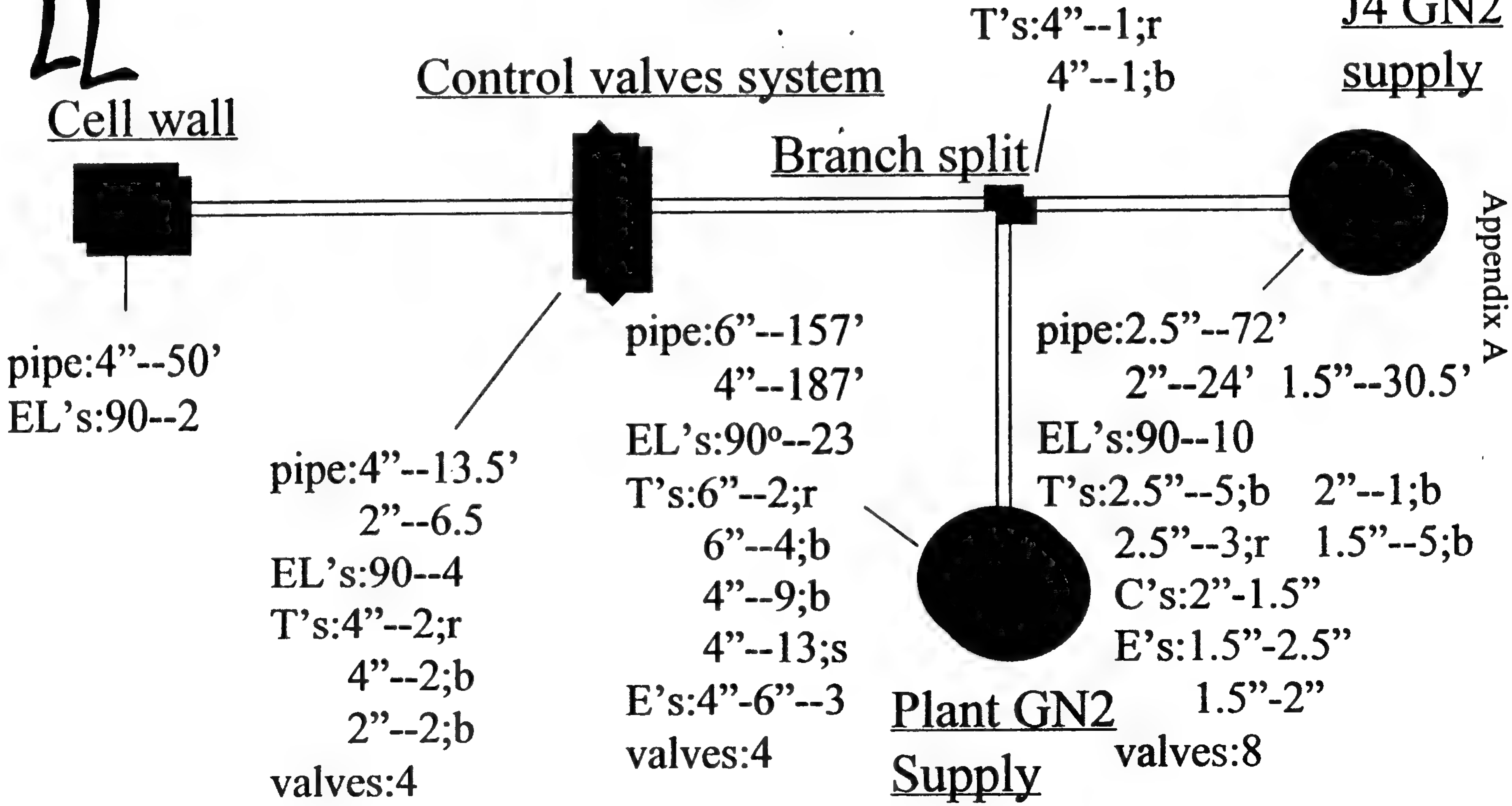
In conclusion, this mathematical model can be used in the scheduling of test operations dealing with the repress system. Currently the required flow rate is an average of 32 lbs. per sec. for a duration for 7 min. According to the pressure and duration curves the flow rate can be maintained safely with the control valve at all three settings.

REFERENCE PAGE

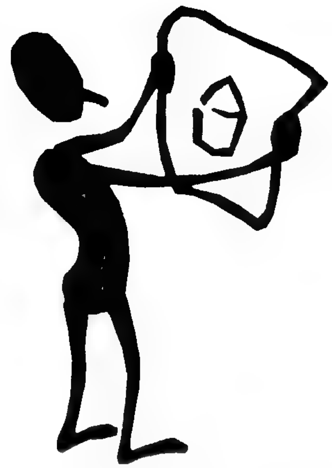
[1] Flow of Fluids Through Valves. Fittings, and Pipe. Crane Co.; Joliet, IL; 1988.

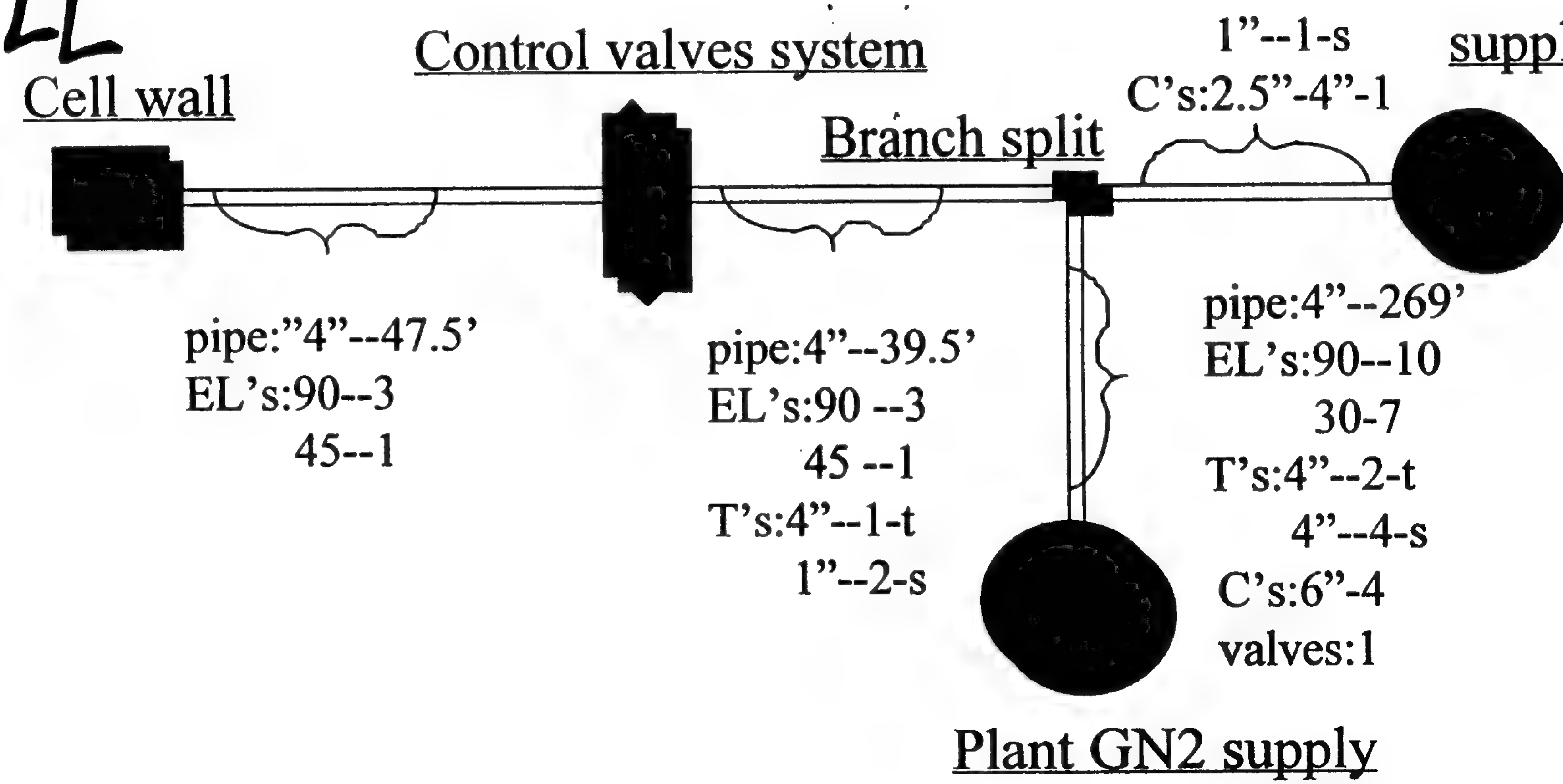


J4 GN2 Systems Configuration



J4 GN2 Pathways Configuration





$w=.525Yd^2(P_{dp}/K)^{(1/2)}$

$P_2=P_1-(w/.255Yd^2)^2*K/p$

PVC2 %:	100	100	100	100	100	100	100	100	100	100
Plant	y	y	y	y	y	y	y	y	y	y
J4	y	y	y	y	y	y	y	y	y	y
Y:	0.7108	0.7108	0.7108	0.7108	0.7108	0.7108	0.71078	0.7108	0.7108	0.7108
rhoi	1.1052	2.2104	3.3156	4.4208	5.5261	6.6313	7.73648	8.8417	9.9469	11.052
M_{tot}:	10	20	30	40	50	60	70	80	90	100
P_m:	222.22	444.44	666.67	888.89	1111.1	1333.3	1555.56	1777.8	2000	2222.2
C_1:	3.8975	5.5119	6.7507	7.7951	8.7151	9.547	10.3119	11.024	11.693	12.325
P_i:	319.36	638.73	958.09	1277.5	1596.8	1916.2	2235.54	2554.9	2874.3	3193.6
rhov	1.5883	3.1767	4.765	6.3533	7.9417	9.53	11.1184	12.707	14.295	15.883
Cv	4.6724	6.6077	8.0928	9.3448	10.448	11.445	12.362	13.215	14.017	14.775
Pv	378.97	757.94	1136.9	1515.9	1894.8	2273.8	2652.79	2994.6	3369	3743.3
20% marg	454.76	909.53	1364.3	1819.1	2273.8	2728.6	3183.35	3593.6	4042.8	4492

K_1:	K_2:	K_3:
22.14346138	31.558	14.756
$K_{1,2combo}$:	13.013	

M final	13960	27921	41881	55842	69802	83763	97722.9	110316	124106	137895
Delta M	124190	110229	96269	82308	68348	54387	40427.1	27834	14044	254.79
Duration (sec)	12419	5511.5	3209	2057.7	1367	906.46	577.53	347.92	156.05	2.5479
Duration (min)	206.98	91.858	53.483	34.295	22.783	15.108	9.62549	5.7987	2.6008	0.0425

DESIGN OF A SEARCHABLE DATA RETREVING WEB BASED PAGE

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Final Report for:
High School Apprentice Program
Arnold Air Force Base

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Arnold Air Force Base

July 1997

DESIGN OF A SEARCHABLE DATA RETREVING WEB BASED PAGE

Jason G. Bradford
Franklin County High School

Abstract

This summer I worked at the AEDC facility with Jason Gamble. The summer's research was focused on designing a Dynamic Database Search Engine for customers using the World Wide Web. This entailed using Hypertext Markup Language (HTML), JavaScript, a Common Gateway Interface (CGI) program written in C, and Java as tools to design and implement a web based Search Engine. The Search Engine allows the user to search a broad field of information quickly and efficiently, narrowing the options as the user selects information, and displaying the desired information in a graph. This Search Engine uses browser based languages compatible with workstations and PC's, allowing access to database information.

DESIGN OF A SEARCHABLE DATA RETREVING WEB BASED PAGE

Jason G. Bradford

Introduction

The World Wide Web is a network of millions of computers linked together. Through the use of special software, known as browsers, they form a network. The web is a distributed network. That means there is no central computer for the World Wide Web. Any server on the network can be accessed directly by a client. Most of the documents on the World Wide Web are written in Hypertext Markup Language (HTML). Users navigate the World Wide Web through browsers and hypertext links. HTML provides the browsers with the instructions on how to display the page. A hypertext link is a string of text that when clicked sends the user to a different Uniform Resource Locator (URL).

The World Wide Web has other common languages between browsers. One of these languages is JavaScript. JavaScript is a fancy term for something that isn't a programming language but is more than just HTML. JavaScript is a Scripting Language that uses sets of grammatical statements and rules combined to give the computer instructions. JavaScript is a more powerful tool than HTML. Another language is the Common Gateway Interface (CGI). This is a standard for interfacing external applications with browsers. CGI is capable of accessing files from a sever and converting the file from ASCII to Binary. This is done to allow users to retrieve files from a server and view them in a Java applet. Another language used this summer was Java. Java applets are designed to be browser independent. Java applets are commonly used to add animation and graphics to web pages.

In recent years there has been a rise in the use of the World Wide Web as more than just a novelty. People are realizing that the web is a useful tool in any line of work. One of the web applications created this summer (The Dynamic Database Search Engine) uses a database that can be updated by someone with little or no programming skills. The potential applications of most interest to the Aerospace Industry is in retrieving data from wind tunnel tests without having to be at the facility. And other applications is in viewing real time plots of the data from anywhere.

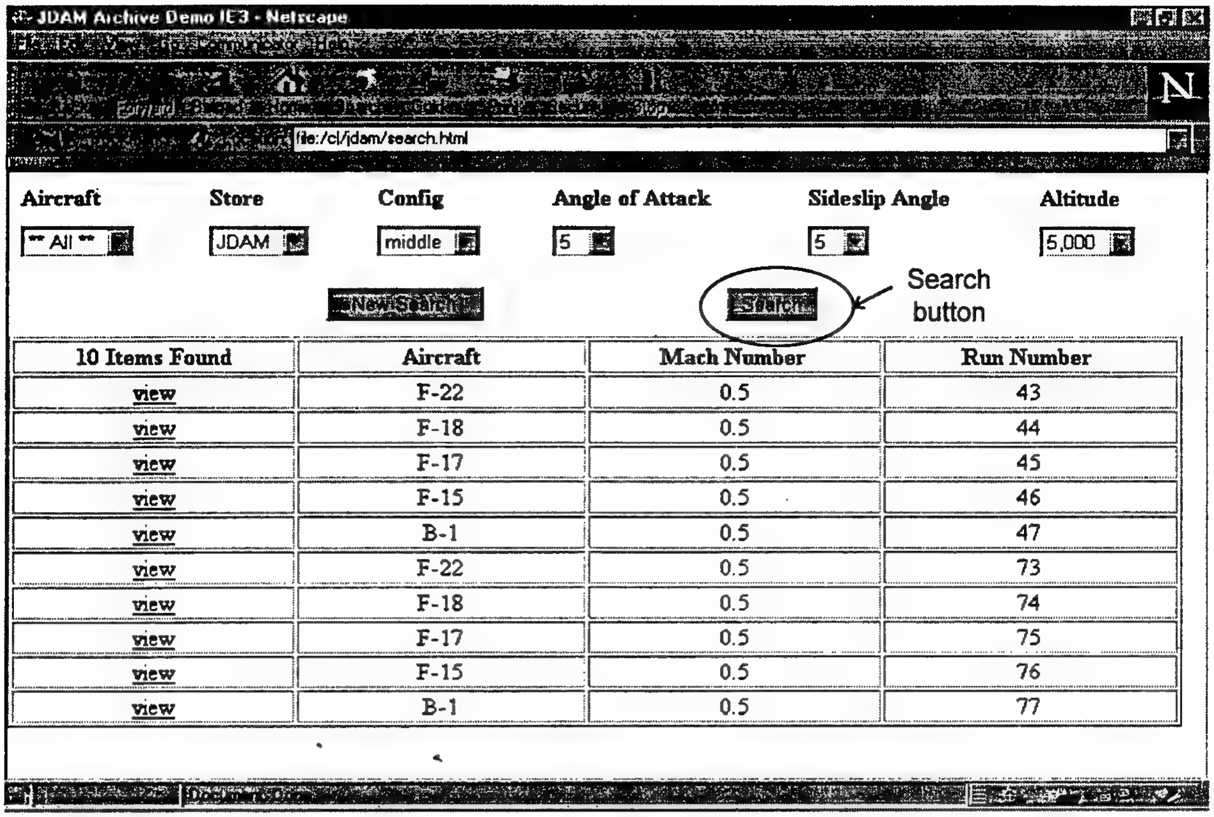
Methodology

First I had to become familiar with HTML and JavaScript. The learning process started with improving a web page for the Aeromechanics Analysis team. Once HTML was understood, an improved

Aeromechanics Analysis team web page was designed using frames and having a separate page for each hyperlink. This new web page was slow to load but had an improved user interface. The team page was then reprogrammed using JavaScript. This did away with loading a separate page for each file and added visual clarity to the hierarchy of the file folders and trees presented in the left frame. The team page then only updated the right frame for each file selected. This approach loaded faster, ran smoothly, provided better visual effects, and reduced the number of files to load.

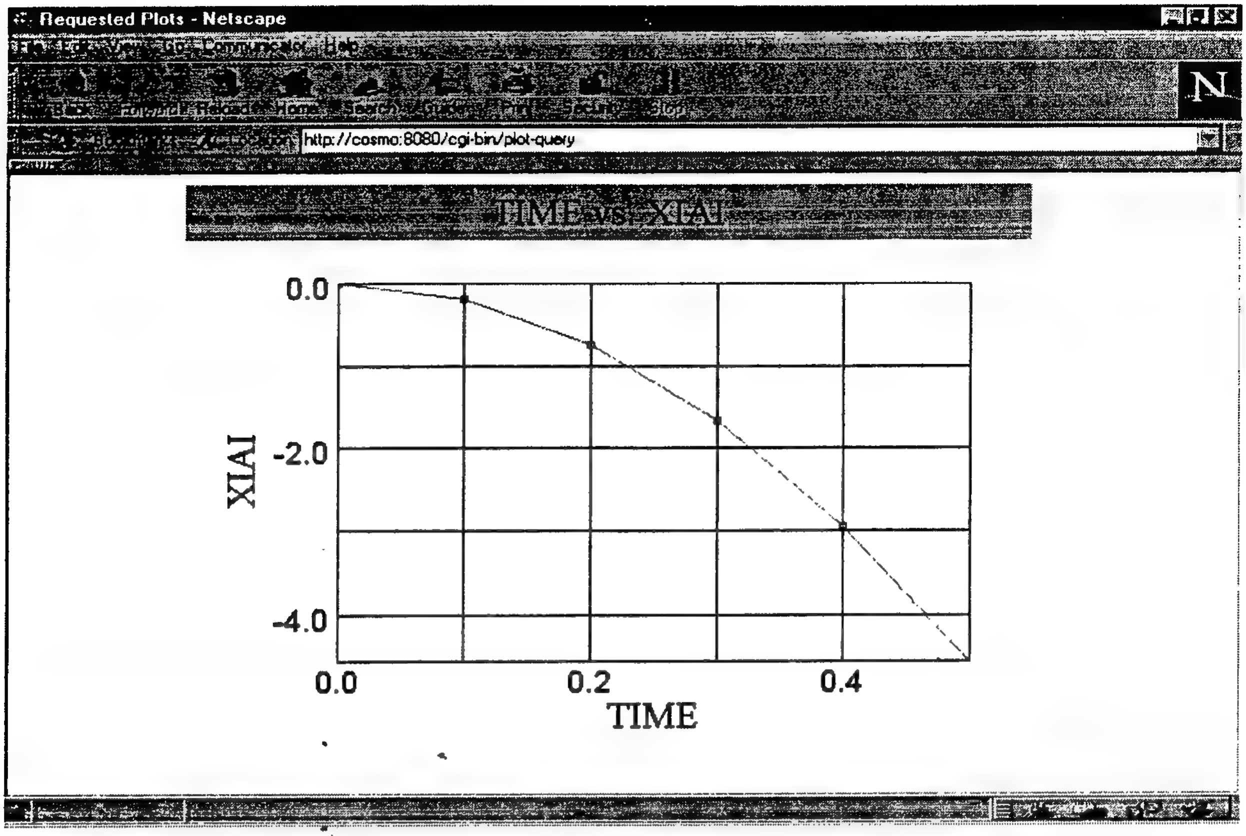
The differences between JavaScript and HTML are significant. HTML is the "glue" that holds web pages together. HTML is the underlining and italics features we are used to with word processors but it is done with HTML "tags" . JavaScript is more complex and able to have the computer perform logic to determine the truth of a statement. This is used to add movement and capability to a web pages. The entire web page is written in JavaScript with the aid of JAVA and C to open and manipulate files.

Once I became familiar with HTML and JavaScript the development of the Dynamic Database Search Engine was started. The first step was to develop the layout of the opening page of the Dynamic Database Search Engine was developed. This page's layout provided pull down list boxes for users selections. As the User selects options from the pull down list boxes, the JavaScript functions narrow the amount of data that has to be searched upon from the large database by filtering out unrelated information. The remaining options available on the page are then narrowed and displayed. Thus, for each choice made, the search from the new database becomes smaller and faster. This is done to keep the user from selecting options not available. Once the user selections have been made, the user can click the search button that will search the entire large database for more detailed options on the selected choices. The results of the search will be shown in the bottom frame of the same page.



10 Items Found	Aircraft	Mach Number	Run Number
view	F-22	0.5	43
view	F-18	0.5	44
view	F-17	0.5	45
view	F-15	0.5	46
view	B-1	0.5	47
view	F-22	0.5	73
view	F-18	0.5	74
view	F-17	0.5	75
view	F-15	0.5	76
view	B-1	0.5	77

When the user finds the appropriate information from the search in the bottom frame, he clicks the "view" hyperlink and a real time graph of the data is shown. The real time graph is done using a CGI program written in C to retrieve the data from the files on the sever, then sends the files to a Java applet which graphs the searched data for the user to view. This showing of the graphed data used the CGI program and a Java applet because JavaScript can't access or plot data ASCII files.



A problem presented itself once JavaScript was introduced to the web page. JavaScript is implemented differently with various web browsers such as Netscape 3.0, Netscape 4.0, Microsoft Internet Explorer 3.0, and Microsoft Internet Explorer 4.0 . To make the search engine work on all browsers, a decision loop was created to look at what type of browser was being used (*i.e.*, Netscape, Microsoft Internet Explorer) and then do the appropriate statements for that browser. This was done to allow all types of browsers to be able to view the data. The different versions of the same browser didn't matter as much as the different name brands. The version variations limited the use of "new" features, but did not prevent the use of the search engine.

Results

This summer's work made me aware of how different two browsers are. It was concluded that Netscape Navigator and Microsoft Internet Explorer are very different. In designing a web page to be accessed from any computer with any type of setup you must, as the programmer; (1) Design separate web pages for each browser, (2) Don't use the most current HTML or JavaScript "tags", or (3) Check for the web browser version and run appropriate loops. In this program the latter of the three choices was used. This allowed

the search engine to work with Netscape for UNIX workstation compatibility as well as working with Internet Explorer for home computer compatibility.

Conclusions

The search engine developed this summer is flexible and can hopefully be used by the Aeromechanics analysis Team in the future. The Search Engine was designed as dynamic as possible for ease of name changing and changing of array sizes. This is a very useful tool to be shared with others. All that you must supply the search engine with is an array of data to search on. The search engine is compatible with every type of browser and computer so anyone can use it's awesome power for searching a huge array of data without having to know anything about the array.

At the beginning of summer, I knew nothing about the web-based languages, HTML, JavaScript, Java, or C. With the training and books I read this summer , I have learned the capabilities and applicability of the World Wide Web. This summer of programming has helped show me the different job fields available and what is required in each job field.

In addition, I learned to communicate with other people because of the many presentations that I made to the different groups at AEDC.

Associates did not participate in the program.

ASSESSMENT OF MICROWAVE HORN ANTENNA RADIATION PATTERN

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Final Report for:
High School Apprentice Program
Arnold Air Force Base

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, Washington, DC

And

Arnold Engineering Development Center

August 1997

Assessment of Microwave Horn Antenna Radiation Pattern

Barbara E. King

AFOSR Summer High School Apprentice

Abstract

An experiment to determine the attenuation of communication signals by rocket exhaust plumes is being conducted at the AF/PL (Air Force Philips Lab). The goal of the experiment is to determine rocket exhaust plume plasma properties, which are needed to analyze the attenuation of communication signals by rocket exhaust plumes. In order to achieve this goal, plume conductivity measurements are being made using microwave diagnostics. At the AF/PL test cell, three pairs of microwave horns will be placed around the diffuser. Each pair of microwave horns will radiate a different microwave frequency. Lenses will be placed on the horns to focus the microwave beams. The electron number density will be determined by measuring the intensity of microwaves radiated and the intensity of microwaves received. Due to the small scale of the rocket motor being tested, an assessment of the microwave beam extent was required. For this assessment, amplitude and phase beam patterns have been measured. The results of these beam pattern experiments are discussed in this report.

Acknowledgements

I would like to first thank the AFOSR High School Apprenticeship Program for giving me the opportunity to work AEDC this summer. This program has given me the valuable opportunity to work in a real work environment. I would also like to thank them for assigning David Pruitt as my mentor. I owe Mr. Pruitt a big thank you for putting up with me this summer. Also, thank you for answering all my questions and helping me with all the many things I didn't understand. Thank you most of all for having a sense of humor. With out the help of Kim, Susanne, and Michael I would not have been able to understand the C-programming language. Thank you all so much for having the patience and kindness to help me. A special thanks you to Suzanne for also being my spades coach. I am also very grateful for having James as my partner. Without his companionship my summer would not have been nearly as enjoyable. Thank you for helping me with my work, but most of all thank you for making me have a great time here. I would also like to thank Gail for just being here. It was real nice to know that we always had you to talk to when we needed to hear a friendly voice. Thank you also for being the only one brave enough to go to lunch with us. Mr. Bishel our AFOSR coordinator was excellent. He deserves commendation for all his efforts in our program organization. Thank you for caring about our opinions and helping us to have a great summer here. Last but not least, I would also like to think everyone else I had the pleasure of meeting this summer. It has been a truly enriching experience.

Assessment of Microwave Horn Antenna Radiation Pattern

Barbara E. King

Introduction

An experiment to determine the attenuation of communication signals by rocket exhaust plumes is being conducted at the AF/PL (Air Force Phillips Lab). The goal of the experiment is to determine rocket exhaust plume plasma properties, which are needed to analyze the attenuation of communication signals by rocket exhaust plumes. In order to achieve this goal, plume conductivity measurements are being made using microwave diagnostics. At the AF/PL test cell, three pairs of microwave horns will be placed around the diffuser. Each pair of microwave horns will radiate a different microwave frequency. Lenses will be placed on the horns to focus the microwave beams. The electron number density will be determined by measuring the intensity of microwaves radiated and the intensity of microwaves received. Due to the small scale of the rocket motor being tested, an assessment of the microwave beam extent was required. For this assessment, amplitude and phase beam patterns have been measured. The results of these beam pattern experiments are discussed in this report.

Discussion

Because a rocket exhaust plume contains free electrons, it is a conductive gas or plasma. The free electrons in the plume reduce the intensity of microwaves propagating through the plume, and so communication links are affected. Thus, it is vital to know the electron number density of a rocket plume in order to assess the degradation of communications links.

To assess the electron number density in a rocket exhaust plume, focused microwave beams are radiated through the rocket plume from a source horn to a receiving horn. The ratio of microwave energy

radiated from the source horn to the microwave energy received can be used to measure the plasma electron number density in the plume. A good microwave attenuation measurement requires the microwave beam to be smaller than the rocket plume[1]. Since the PL experiment involves a small rocket motor, a focused microwave beam will be used. In order to be sure the microwave beam is smaller than the rocket plume, amplitude and phase beam patterns have been measured. The results of these beam pattern experiments are discussed in this report.

Methodology

An experiment was conducted to map the amplitude and phase of a focused microwave beam. The basic measuring arrangement consisted of a 10GHz point source, which radiated microwaves through a six-inch horn. The horn served as both the microwave source and receiver (a monostatic measurement). The horn was fitted with two lenses. The inner lens had a 6-inch focal length. This produced collimated or parallel microwaves. The outer lens, which had a focal length of 24 inches, received the collimated beams and refocused the beams toward the twenty-four inch focal length. A one-inch steel ball mounted on a horizontal translating stand was used as a probe. As the steel ball was scanned radially across the microwave beam, a small fraction of the microwave energy falling of the ball was reflected back to the source horn. The phase and amplitude of the reflected microwave data were recorded as the ball translated.

The radial scans started twelve inches from the beam axis and scanned for twenty-four inches. The first radial scan was taken at 4 inches from the horn. Subsequent radial scans were completed at one-inch increments along the beam axis, ending at 30 inches. Data was recorded at .01" increments along each radial scan. Figure 1 shows the schematic of the basic measuring arrangement. Figure 2 and 3 are typical phase and amplitude profiles.

Due to the fact that only a small fraction of the microwave energy was reflected off the ball back to the horn, the received microwave signal was weak, and the recorded signal was noisy. An algorithm called box-car-average was used to smooth the data[2]. The algorithm takes a window of data (in this case the

window contained fifteen samples), averages the window, replaces the middle number with the averaged number, and then increments by one sample to repeat the operation. The result is a smoothed radial profile needed for contour plotting. The box-car-average was used to smooth all amplitude and phase radial profiles by incorporating the algorithm into a C-program[3]. Figure 4 shows an application of the Box-car-average algorithm.

For some of the phase profiles, the measuring hardware caused the phase data to "wrap". That is, the instrument can only report data between −180 degrees and 180 degrees. If the phase were greater than 180 (or less than −180), the instrument would automatically "wrap" the data to the negative equivalent. In order to correct the wrapped data, three-hundred-and-sixty degrees had to be added to the wrapped profiles. This was achieved by adding functions and loops to the C-program.

After all the phase and amplitude profiles were processed by the C-program, they were sent to a plotting program known as FAST[4]. FAST has the capability to create contour maps of phase and amplitude from the radial scans collected at all the axial locations. The contour maps are useful to show the variation of the amplitude and phase in the microwave beam. Each curve in the contour map indicates a region where the amplitude or phase is constant. The value of the curve is given by the color of the curve. The edge of the microwave beam was revealed by the areas of rapidly changing amplitude or by the closely spaced contour lines. Figure 5 shows the phase and amplitude contour maps.

Results

The contour maps of amplitude and phase allow several features to be observed. The beam amplitude ranged from 0dB (reference) on the beam centerline to −40dB away from the beam. The amplitude map revealed 2 distinct side lobes. The side lobes are seen as structures near the source horn that radiate at an angle away from the centerline of the main beam. The 10dB beam width was about 4 inches at the 24-inch location. Although the focal length of the source-horn lens was 24 inch, the actual focal length appears to be 12 inches. The phase map confirms the focal point identification. The phase map showed a change of

curvature at 12 inches, which indicates the focal point. Figure 6 shows half the amplitude contour map scaled with the microwave horns.

Similar data have been acquired by a previous investigator[5]. When the amplitude map was compared to data from reference 5, important observations were made. Both contour plots of amplitude have similar features. Side lobes are present in both maps. Also the dynamic ranges are the same. However one important difference was noted. Farnell's beam is focused at the 24-inch focal length of the lenses. Figure 7 shows Farnell's amplitude map.

In order to assess the application of the microwave beam in the PL test cell, the rocket exhaust plume was superimposed on the scaled drawing of the microwave beam. Figure 8 shows the scaled drawing. The implications for the PL experiment are positive. The 10dB beam width is well within the rocket exhaust plume.

Conclusion

Radial profiles of phase and amplitude for a microwave beam were recorded. Radial profiles were plotted to remove artifacts and smooth noise caused by the method of recording the microwave signal. Contour maps of phase and amplitude based on the smoothed radial profiles were created in order to visualize the microwave beam. The phase and amplitude contour maps were compared to data from previous investigators and to the PL test cell geometry. The microwave beam is within the rocket exhaust plume boundaries indicating that a successful attenuation experiment is feasible.

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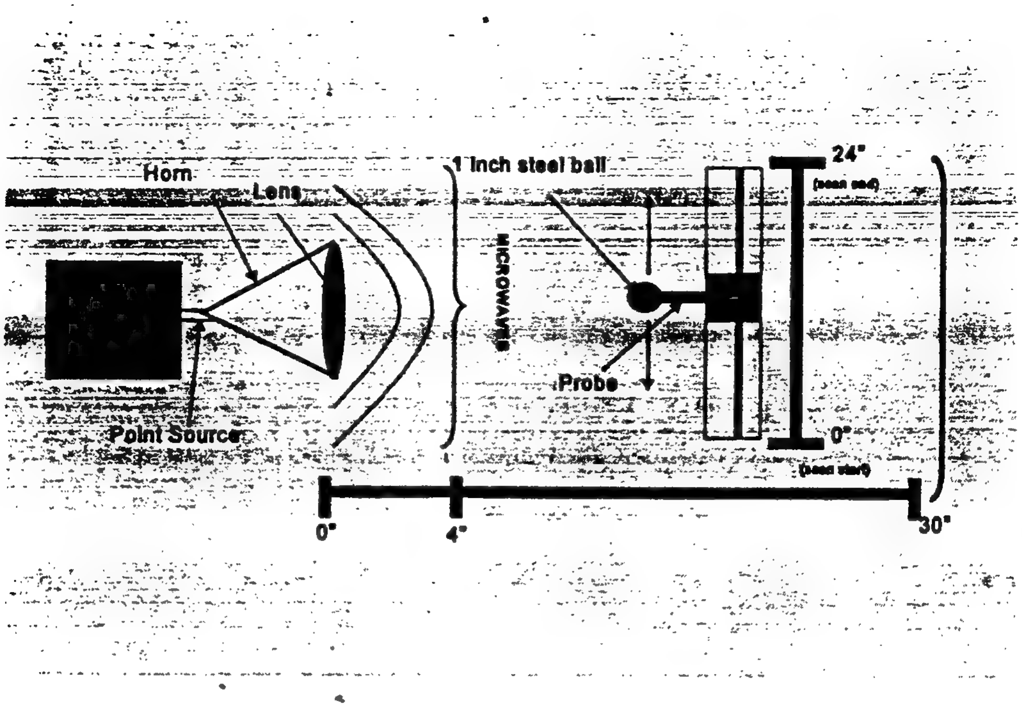


Figure 1. Basic Measuring Schematic

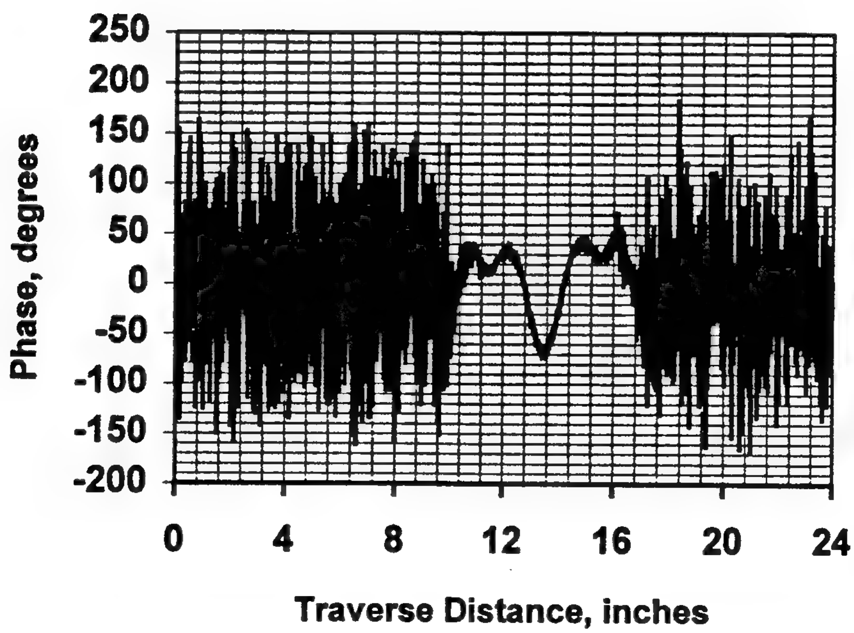


Figure 2. Typical radial profile of microwave beam phase

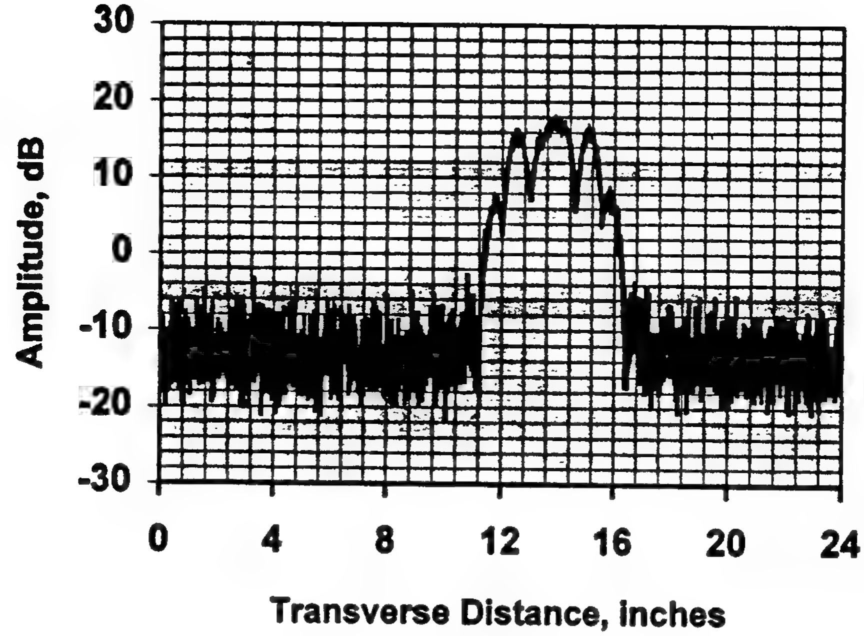
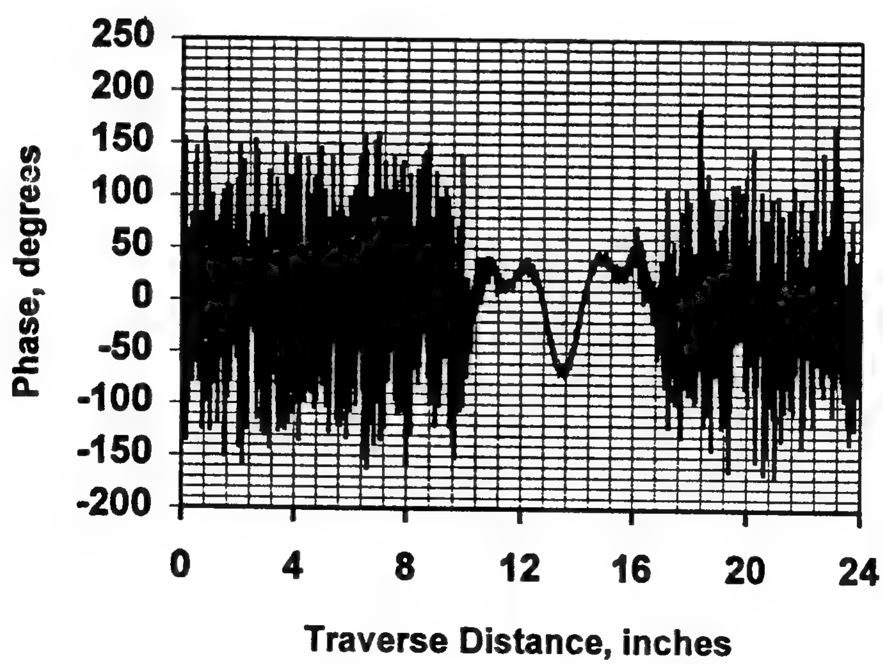
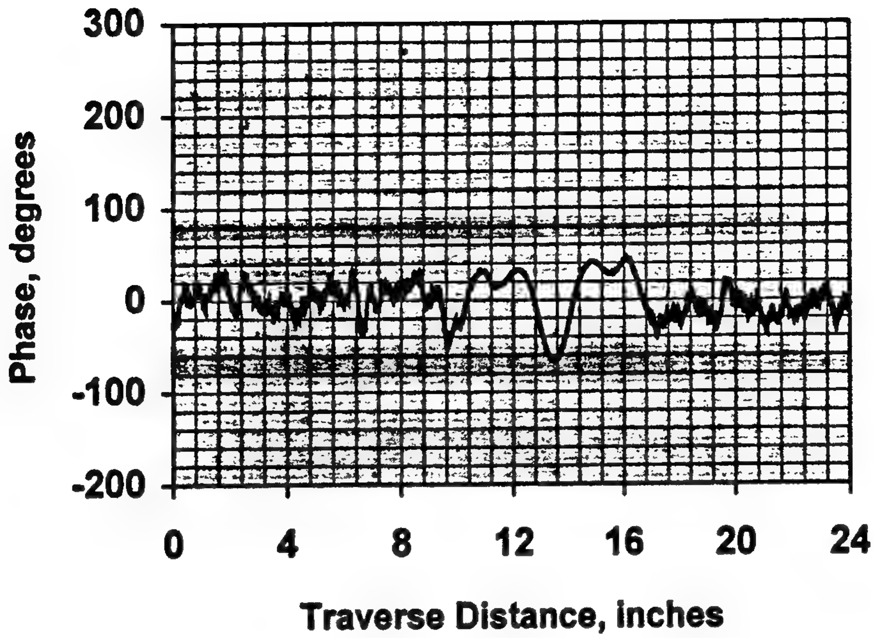


Figure 3. Typical radial profile of microwave beam amplitude

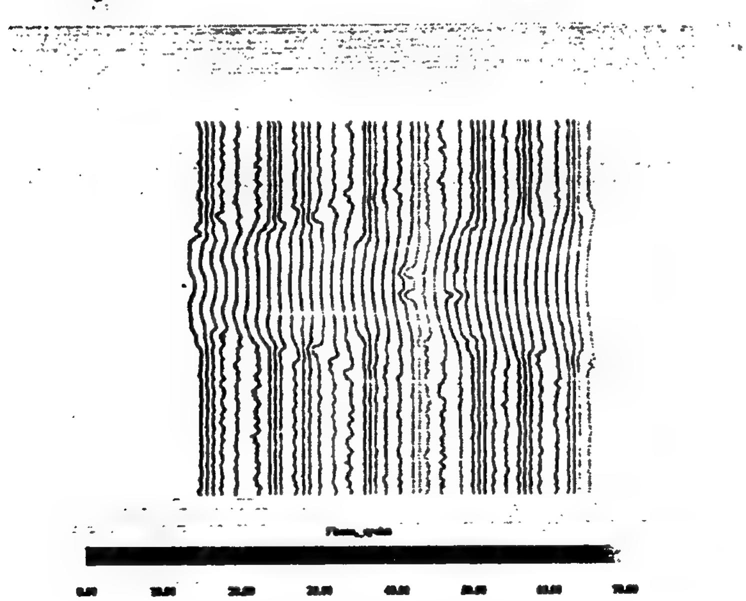


a. Raw Data

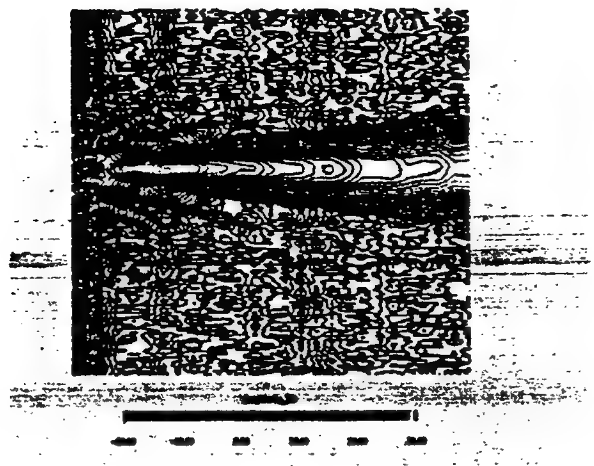


b. Smoothed Data

Figure 4. Application of Box-Car-Averaging Algorithm



a. Phase contour



b. Amplitude contour

Figure 5. Application of FAST plotting program

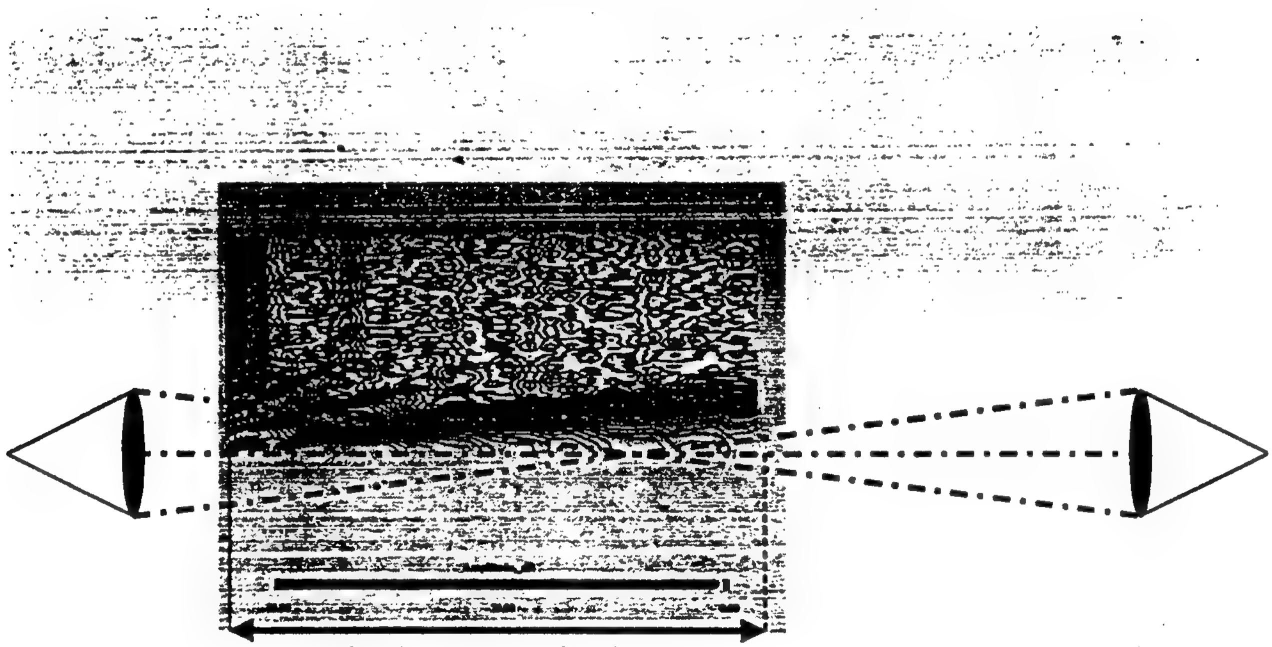


Figure 6. Scaled drawing of Amplitude

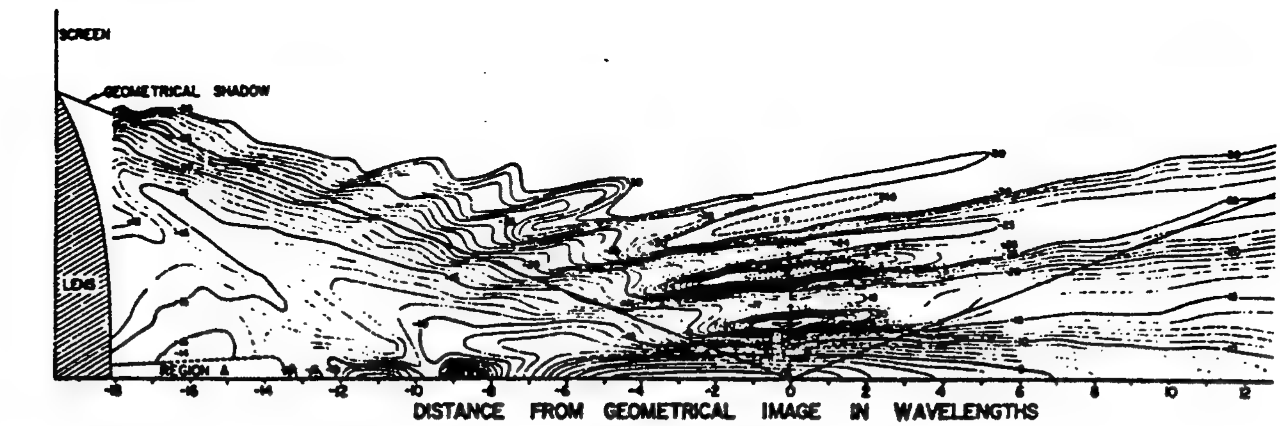


Figure 7. Farnell's data

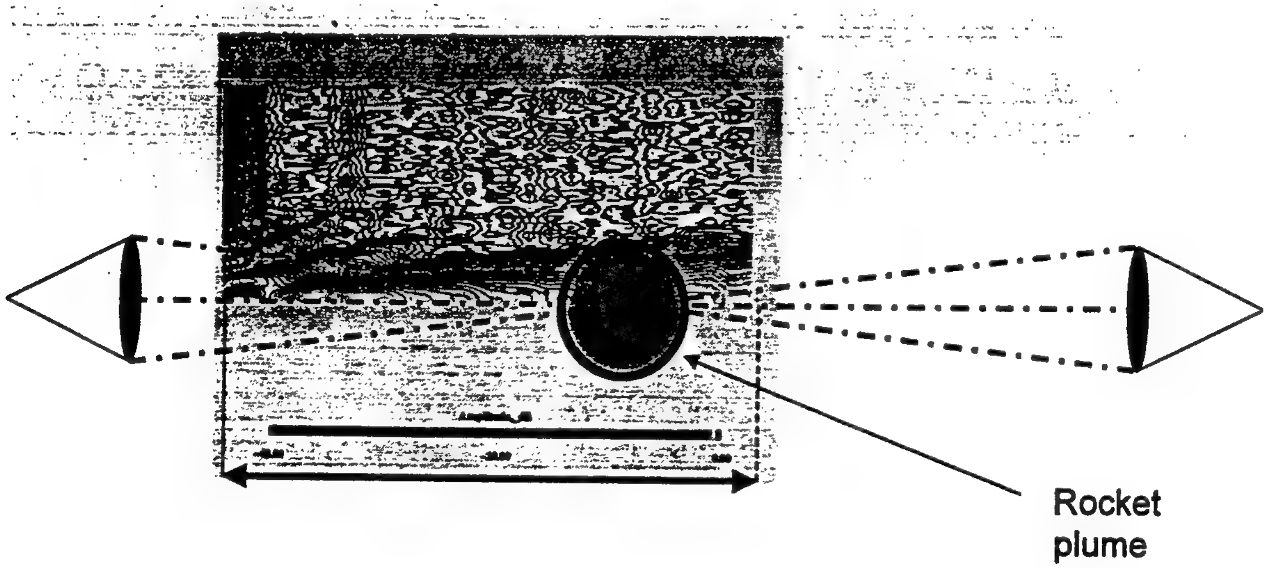


Figure 8. Scaled drawing of the PL test

Analysis of DWSG Characterizations

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Final Report for:

High School Apprentice Program

Arnold Engineering Development Center

Sponsored by:

Air Force Office of Scientific Research

Bolling Air Force Base, DC

and

Arnold Engineering Development Center

August 1997

Analysis of DWSG Characterizations

Kaitrin T. Mahar

High School Apprentice

Coffee County Central High School

Abstract

Arnold Engineering Development Center's Focal Plane Array Test Chamber tests infrared focal plane arrays, important components of strategic and tactical weapons sensor systems. It simulates space-like environments and mission scenarios created by Direct Write Scene Generation. The data from this testing can be analyzed using Visual Basic programming.

Analysis of DWSG Characterization

Kaitrin T. Mahar

High School Apprentice

Coffee County High School

Introduction

Testing equipment designed for use in space satellites is expensive if actually done in space. Testing requires simulating the conditions in which the sensors will be working and creating scenarios similar to those the sensors will "see," despite the fact that the sensors are still on Earth and not looking down at it. The Focal Plane Array Testing Chamber (FPATC) at Arnold Engineering Development Center (AEDC) tests infrared focal plane arrays, which are important components of such systems.

Focal Plane Arrays

Focal plane arrays (FPAs) and their data subsystems are the parts of sensors that actually "see." FPAs are made up of rows and columns of pixels, hence the term array. They are placed at the spot where an image comes into focus, i.e., the focal plane. The photoelectric effect makes FPAs work. Photons within a certain range of wavelengths striking a pixel cause an output voltage. Output voltage varies directly as the number of photons striking the FPA. Each pixel stores the photo-electrons for a short time period called the integration time. After that, all the output voltages are read out to the data subsystems. The FPA resets itself and begins collecting photo-electrons again. Figure 1 shows a 256 × 256 FPA.

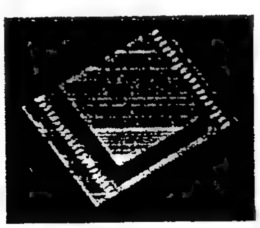

Figure 1. Typical FPA[1]

The FPATC

The FPATC can run several types of tests on FPAs. The FPA being tested is placed inside a Lakeshore Modular Test Dewar (see Figure 2) where liquid helium or liquid helium can keep it cold enough to simulate the conditions in which it will eventually work. The major types of tests run on FPAs in the FPATC are blackbody characterization, laser compatibility, Direct Write Scene Generation (DWSG) characterization, and mission simulation.

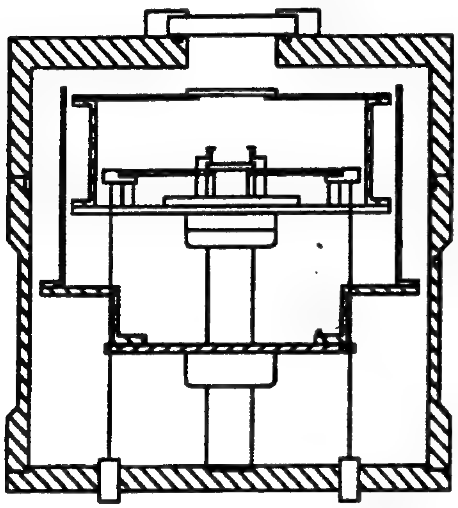

Figure 2. Lakeshore Modular Test Dewar (cross-section).

Blackbody Characterization

Before DWSG mission simulation can start, it is necessary to know more about the FPA being tested. Blackbody characterization uses a reference blackbody source with known photon output to calibrate the FPA and to assure that the FPA works correctly at the wavelengths it will encounter in real world missions. (The wavelengths used by DWSG are generally higher.) The numbers of photons hitting the FPA can be varied by changing the size of the aperture, changing the blackbody's temperature, etc. Knowing the number of photons hitting the FPA makes it possible to plot a response curve comparing the number of photons to the output voltages.

Laser Compatibility

Since DWSG uses a scanning laser, the radiation is not exactly like that from the blackbody, nor is it continuous like the blackbody tests. Table 1 shows comparisons of blackbody sources, DWSG, and real world sources.

	DWSG	**Blackbody**	**Real World**
Spectral	Non-mission	Mission	Mission
Temporal	Pulsed	Continuous	Continuous
Other			
- Bandpass	Monochromatic	Planck	Multi-spectral
- Coherence	Coherent	Incoherent	Partially Coherent
- Polarization	Polarized	Unpolarized	Partially Polarized
- Noise	Poisson	Poisson	Poisson

Table 1. Comparison of Projection Source Characteristics[2]

Laser compatibility testing assures that FPAs respond in the same way to laser radiation that they do to blackbody and tests FPA response to pulsed radiation. Ideally, the signal achieved by using continuous radiation can be duplicated by multiplying the Radio Frequency (RF) Power, which controls the intensity of the laser, by the inverse of the pulse width's ratio to the integration time. This is illustrated in Figure 3.

Another quality measured during laser compatibility testing is crosstalk. Crosstalk describes the signal "leak" that occurs between pixels. It is measured by positioning a laser beam on four pixels, as shown in Figure 4. This confines the light from the laser beam to the four pixels and allows the signal bleed to the surrounding pixels to be accurately measured. After taking both pulsed and continuous data, Interactive Data Language (IDL) software is used to subtract tare intensities from the data and to calculate

the average intensities in each data file for each pixel (in pulsed mode, applicable only to those frames with the laser operating) in the area around the four on which the laser is focused. Files containing the reduced data are imported to a Microsoft Excel template which calculates the average crosstalk. On most FPAs tested so far, crosstalk averages less than ten percent.

Total energy under curve should be the same.

Continuous Irradiance

Pulsed Irradiance

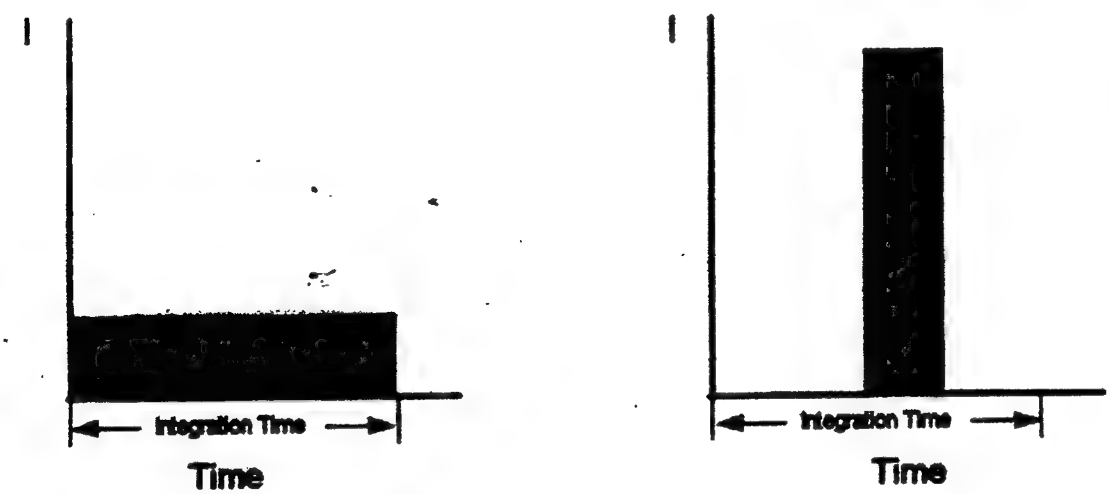

Figure 3. Total integrated energy.[2]

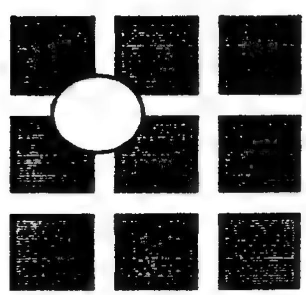

Figure 4. Positioning of laser beam in

crosstalk measurements.[3]

Mission Simulation

The key to the FPATC is the Direct Write Scene Generation(DWSG) technique. It is used to project complex scenes directly onto the FPA in real time. DWSG uses acousto-optic (AO) cells to position and control the intensity of a laser beam that paints a scene onto a FPA. The concept is similar to that of a cathode ray tube, but instead of a single beam of electrons scanning the whole FPA, the laser beam is divided into many beams covering the vertical axis, like a rake. This rake scans across the horizontal axis. Figure 5 illustrates this concept.

GSFs

Scene data to be projected onto the FPAs and scene data sent back from the FPAs are stored in Generic Scene Files (GSFs), with a *.gsf extension. The path of the data is shown in Figure 6. Input GSFs are different from output GSFs. For example, the laser intensities fed to the electronic system might be on a scale of 0 to 255, while those that the FPA reads out might be on a scale of -3 to 3. Another difference is the order of the files. Scene files, when projected onto the FPA, do not always start at the beginning of the scenario. It is easier to keep the scene playing and begin taking data at random, telling the computers to take as many frames as exist in the scene. A checkerboard frame identifies the actual first frame of the input file.

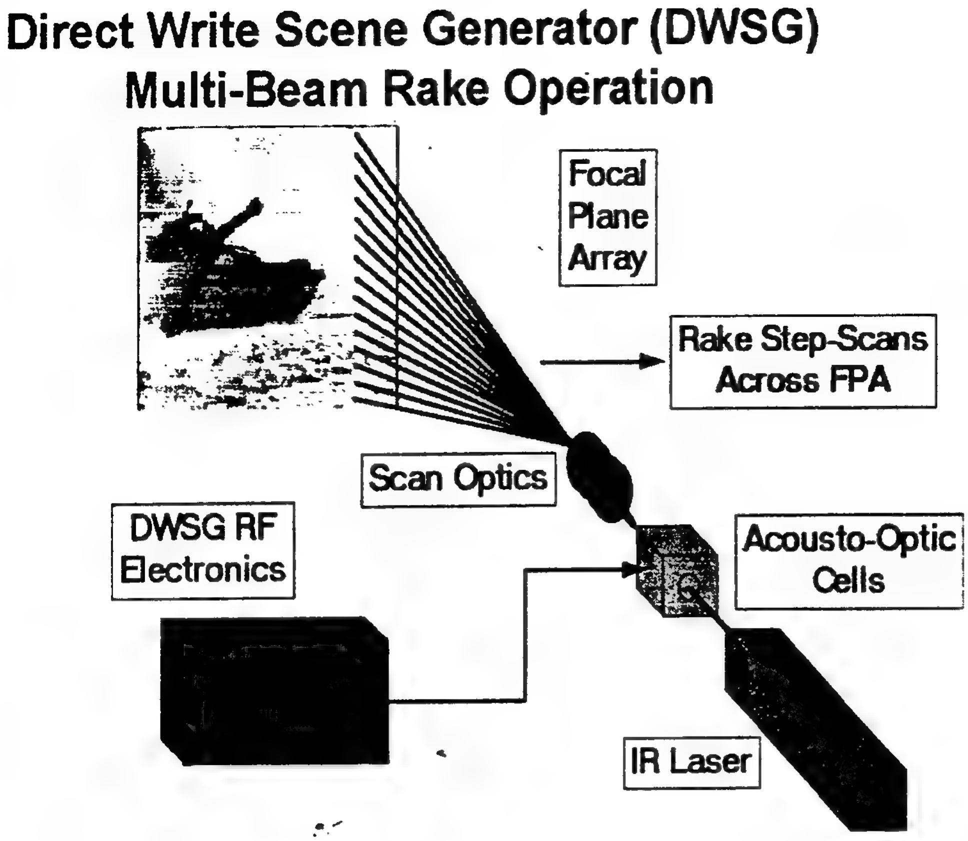

Figure 5. DWSG Operation.

Besides starting in random locations, FPAs send back data in a different format than it was sent to the AO cells. The laser system may only be projecting to a 64 × 64 pixel area. Often, FPAs are 128 × 128 or larger. In the 128 × 128 example, the scene is projected in four parts within each integration time. Four frames of input data equal one of output data.

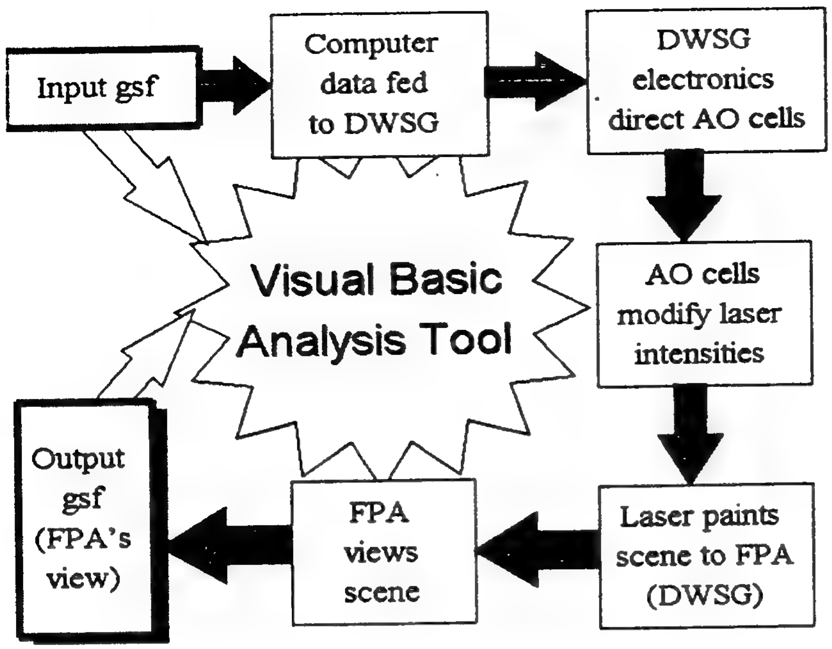

Figure 6. Path of GSF data.

Visual Basic Application

This summer's project was to make and use a Visual Basic application capable of converting input and output files so that they can easily be compared and identify and hopefully solve any problems. The final user interface for the application is shown in Figure 6.

The Visual Basic application loads GSFs as two-dimensional arrays. It uses simple mathematical formulas and commands to perform its subroutines. The first subroutine is designed to track a single pixel through each frame of a GSF. It prints these intensities to an output file of the user's choice, usually a *.dat file. These files can easily be transferred to MS Excel to plot the intensities. The second subroutine is very similar, but it tracks the same pixel in two different files. This can be used to compare one pixel in an input scene file with its counterpart in the output scene file. Another subroutine compares the intensities of all the pixels in two GSFs and writes a new GSF so the differences can be viewed. Before subtracting an input file from an output file, though, it is necessary to convert the maximum and minimum values of one of the files so that it is on the same scale as the

other file. This is accomplished with another subroutine which converts a GSF to a uniform scale of the user's choice.

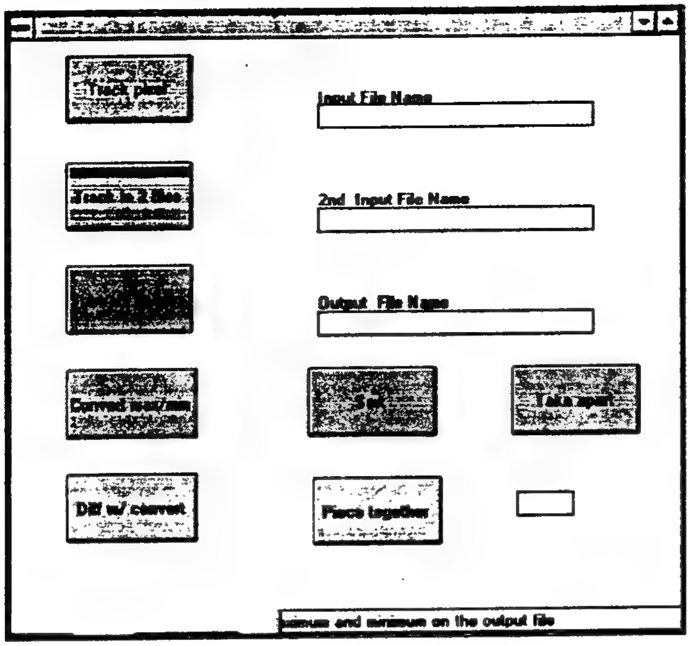

Figure 6. Visual Basic application user interface.

To compare input and output GSFs, the files must be in the same order. One of the subroutines on the Visual Basic application deletes the checkerboard frame from the output GSF and writes a new GSF which starts with the frame after the checkerboard frame (the input GSF's beginning), goes to the end of the data taken by the FPA, and then goes back to the start of the data GSF and runs to the frame before the checkerboard. This creates a file which can be compared with the file which was projected onto the FPA.

The new Visual Basic application also handles the format problem. It can cut each output GSF frame into four pieces or it can combine every four frames of an input GSF.

Results

Unfortunately, testing for the data which was to be analyzed was delayed because of computer problems, vacations, and other factors. The software

seems to perform its intended functions on files from old data, so should work for future FPA testing.

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WRITING A COST ESTIMATE PROGRAM USING THE JAVA PROGRAMMING LANGUAGE

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Final Report for:
High School Apprenticeship Program
Arnold Engineering Development Center

Sponsored by:
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Bolling Air Force Base, Washington, D.C.

and

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August 1997

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Steven W. Marlowe

Abstract

The Aircraft Systems Department of Arnold Engineering Development Center has seen a need for a quick, efficient, and easily accessible cost estimation process. To fill this need members have hypothesized about the writing of a computer program to receive specific information about a test and convert it into an accurate estimate of the cost for such a test. An application to estimate the programming hours required for a specific test was written for the Data Support Team, a smaller entity of the Aircraft Systems Department. This program was written using the Java programming language. The use of Java for this project enabled any computer on the network using a standard browser to access the program and quickly estimate the cost for a specific test. Based on this program for the Data Support Team, the decision was made to develop a similar program for the Aircraft Systems Department using Java.

Acknowledgments

My thanks must go out to all of the people who have helped and supported me this summer. This includes everybody in my office and the entire Data Support Team. A special thanks to Danna Pemberton, for helping me with all of those sticky Java situations. Also thanks should go to my mentor Joe Thompson.

WRITING A COST ESTIMATE PROGRAM USING THE JAVA PROGRAMMING LANGUAGE

Steven W. Marlowe

Introduction

The Java programming language is a very new and exciting language for software engineers. It is based on the Object Oriented Programming concept and takes this to a new maximum, as nearly everything in Java is an object. It also provides new functionality by being platform independent. For example a Java program can be written on a PC, and then be used on a Macintosh or Unix Workstation. This is a very wonderful feature as before separate applications would have to be written for each platform. To achieve this the Java compiler creates virtual machine code instead of processor specific code. This virtual machine code is then later converted into processor specific code at runtime. Another appealing capability of Java is that it can be written in the form of an applet and ran within a Java enabled Internet browser. The combination of this applet-ability and platform-neutrality make it an ideal language for use on networks or the Internet. This functionality is implemented by writing a web page using HyperText Markup Language (HTML) and embedding a Java applet within it. When the page is accessed, the applet is started and its virtual machine code is downloaded onto the user's computer. Then it is converted into processor specific code by the browser and runs locally on the user's computer to improve performance.

Methodology

To begin my project of writing a cost estimate program for the Data Support Team, I first downloaded the Java Development Kit and studied the Java programming language. I had many resources at my disposal, including several books, the Internet, example programs, and most importantly a real-live Java programmer, Danna Pemberton. I began by reading books and writing/modifying the example programs in the text. After grasping some basic concepts, I then began writing some of my own small programs to test out my skills. Furthermore, I scanned the internet and looked at several example

programs, questions & answers, and etc. In addition to my study of Java, I briefly reviewed a limited amount of HTML, which was required to create web pages for applets. Of course I also had many of my own questions which were answered by Danna all along the way.

Next I was presented with the specifications for the cost estimate program. They seemed quite overwhelming at first as I have had no previous programming experience, but after some thought and careful preparation the task seemed workable.

First I did a little more reading on Graphical User Interfaces (GUI). I learned about different types of buttons, checkboxes, text boxes, drop-down lists, and etc. Then I began to design the interface. I set up choice boxes for the particular wind tunnel, test type, amount of data reduction, etc. Also text boxes were installed for the user to input the number of days the test was to take place and for number of days the installation of the model would take. Various other types of inputs were also incorporated including the all important "calculate button." I looked at some specific examples of other GUIs and wrote several different versions of the interface until I found a suitable one for this project. With the great number of buttons, various inputs, and output displays it was tough getting them all to fit on the screen, but careful layout soon prevailed.

Second was capturing the action events associated with the numerous inputs. These events allow the user to interact with the applet. For example, the buttons became clickable and also responsive to the clicks. The drop-down menus were filled with choices instead of being empty. The checkboxes were able to be checked, unchecked, and then rechecked again. Also the text boxes were able to receive and store typed information. It was fun to see all the various inputs at work, but they were not very useful in this state; they needed to be used in the calculations.

Third was writing the code to do the dirty-work of the system. This step also required lots of thought in order to get the calculations correct. I used several different variables in order to store the number of hours that corresponded to a particular user input such as test type, data reduction, or number of days of installation. The action events of the previous step were then defined to extract the correct number of hours for the particular input and insert it into the algorithm used to calculate the total. Finally the "calculate button" was set up to begin the calculations and display the totals on the screen.

Fourth was the testing/debugging stage. This required doing several different calculations manually and recording the totals on paper. Then these same inputs used in the manual calculations were tried on the applet. If the totals did not match, I had to hunt down the problem and correct it. The most common error came up if the user set an input and then later changed it before calculating the totals. In the original version this made the totals read too high. Soon this was corrected and all was well with the program. Also at this time, the applet was modified to read data from a local file instead of it being hard set in the program. This feature was implemented to allow anyone to change the number of hours required for a particular input, even if they have no experience in Java.

The fifth stage of this project came in putting the applet to use. With the help of Danna, the applet, accompanying HTML page, and data files were sent to a server local to AEDC. From there the applet was again tested and the address was then distributed for others to use.

Results

The result of this project was two-fold. First it gave the Data Support Team a tool to use in estimating the cost of future wind tunnel tests. Second it helped in the decision to produce a Java applet to calculate complete estimates for the Aircraft Systems Department. Also it will serve as a model for this upcoming cost estimate program.

Summary

This summer has been a very fun, exciting, and profitable one for me. I came here with very limited computer programming experience and absolutely no exposure to the Java programming language. Furthermore, I had never used a Unix based computer system before. Also I had not had any previous connections with a professional office setting before. All of this has changed. I have adapted to and enjoy working in the environment that was presented to me. I gained some skills and practice on a Silicon Graphics Workstation running a version of the Unix operating system. I have also learned much about computer programming especially Java programming. As I leave this summer I will take all of this with me... the experience, the knowledge, and the ability of a true Java programmer.

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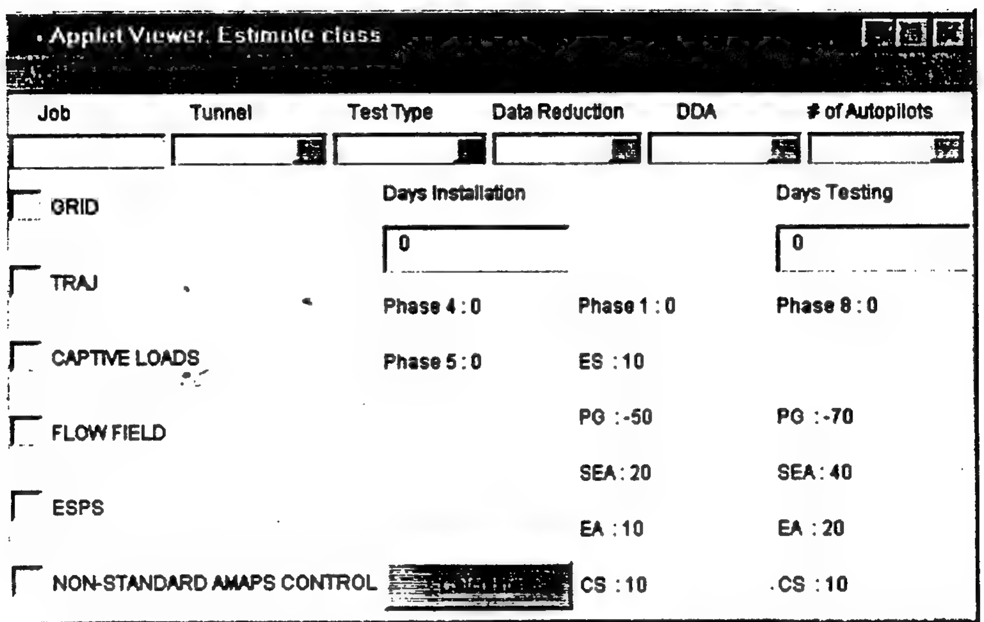
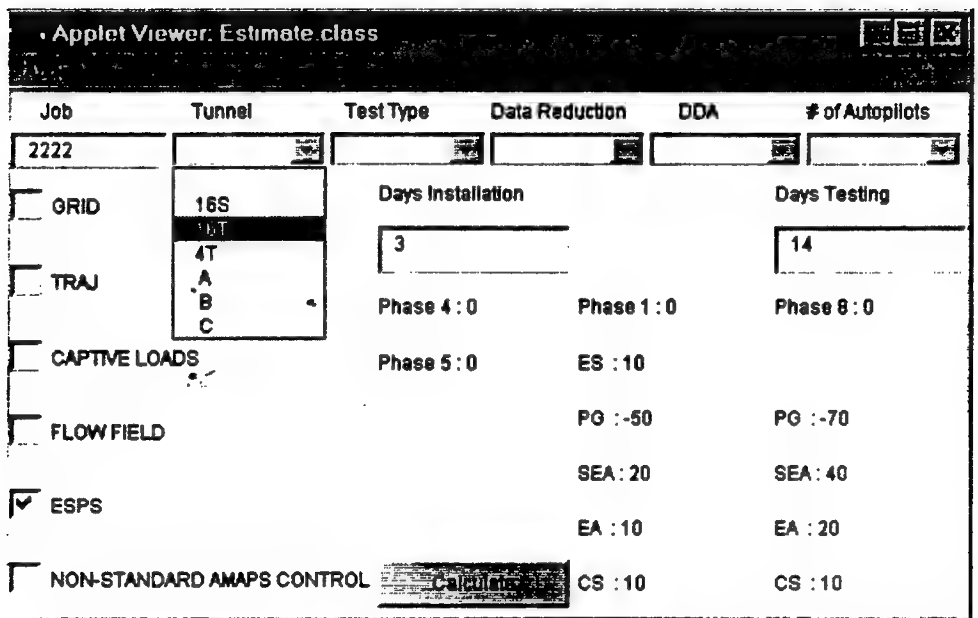
Jamsa, Kris. Java Now! Jamsa Press, 1996.

Suleiman, Lalani and Kris Jamsa. Java Programer's Library. Jamsa Press, 1996.

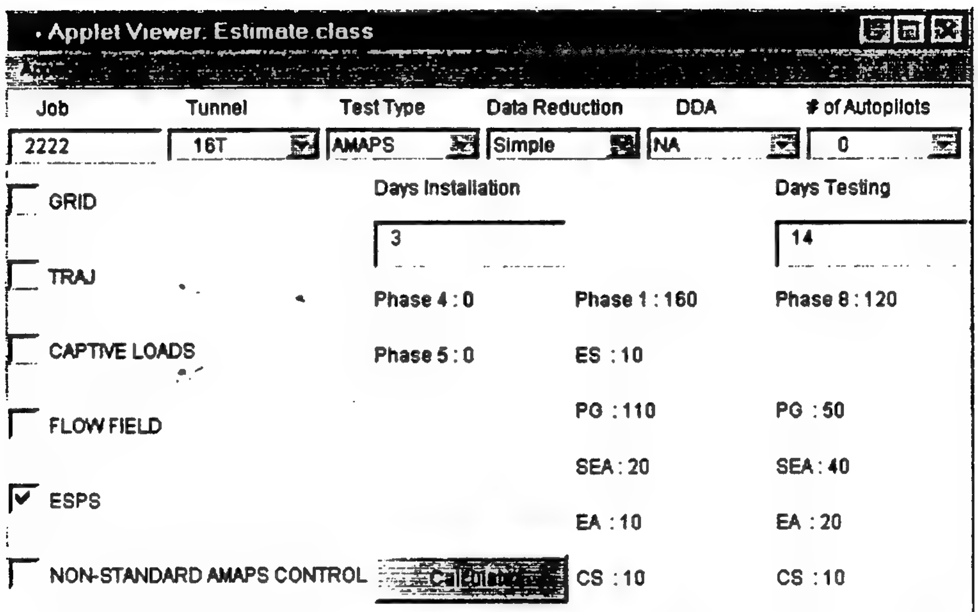
Beginning screen for Data Support Team Estimate Program.



Fill in the appropriate inputs.



Final Estimate is calculated.



CONSTRUCTION OF A GRAPHICAL USER INTERFACE FOR THE THERMALLY PERFECT GAS CODE

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Final Report for:
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August 1997

CONSTRUCTION OF A GRAPHICAL USER INTERFACE FOR THE THERMALLY PERFECT GAS CODE

Michael R. Munn
University of Notre Dame

Abstract

A graphical user interface was constructed to provide an effective method for creating a data file of gas thermodynamic properties. Previously, there was a FORTRAN code that contained 185 gases and the user had to type in each of the gases he or she wanted to include in their mixture. This method was both tedious and confusing. Therefore, a graphical user interface was created using the Tcl and Tk computer languages. The resulting program is much more convenient, easier to understand and the user invokes a point and click method to choose the gases.

CONSTRUCTION OF A GRAPHICAL USER INTERFACE FOR THE THERMALLY PERFECT GAS CODE

Michael R. Munn

Introduction

In recent years, computer modeling has begun to play a more dynamic role in the testing of engines and other aircraft. However, when modeling the performance of these machines at different altitudes and speeds, it is necessary to consider the properties and nature of the surrounding atmosphere. Because the atmospheric conditions can change in the types and numbers of gases present during the flight, a program is required to allow the user to test how the machine will perform in various conditions with different gases.

The preprocessor for the thermally perfect gas code [1,2] did just that. It accessed a database that defined properties for 185 gases, some with multiple definitions, and allowed the user to choose as many different gases as desired to put into the artificial atmosphere. However, this program required the user to type in the name exactly as it appeared in the database. Despite its usefulness it was still rather inconvenient and cumbersome. Therefore, a new program was needed containing a graphical user interface that allowed the user to point and click on the desired gases and then save them to another file. This new program would eliminate the need to type every gas name and alleviate any confusion for the user.

Methodology

To create the graphical user interface for selecting the gases, it was first necessary to become familiar with the Tcl and Tk computer languages. These powerful computer scripting languages work together to produce a highly effective graphical interface that very closely resembles the format found in almost any Motif application. Tcl (Tool

command language) provides the generic programming facilities, such as loops, if statements, variables and procedures, that are frequently used when writing any program. However, although Tcl is equipped with all of the essential programming features, it is usually not used by itself. Tcl is intended to be used in conjunction with Tk. Tk acts as more of a toolkit for the X Window System and extends the core Tcl usage with powerful commands used for building user interfaces that have to ability to include impressive graphical features such as windows equipped with listboxes, titles, buttons, scrollbars, menubars and just about anything else. This makes Tk the most useful extension to Tcl [3]. Copies of both Tcl and Tk can be obtained from Sun Microsystems at http://sunscript.sun.com .

When writing the program, a gas database containing all of the 185 possible gaseous species had to be accessed and inserted into the graphical interface so they could be selected by the user. Each of the entries in the database listed the name of the gas, the molecular weight, the temperature ranges spanned by that particular gas, the curve fit coefficients for each temperature range and a few comments about the gas. In order to list each of the gases in the interface, the entire database was first converted into a system of arrays and then printed into a scrollable listbox named "Gases" (Figure 1). This made listing the gases as well as choosing the gases much easier from the programmer's standpoint. This file could be opened using the menubar. The menubar contained two topics, *F*ile and *H*elp. The File button allowed the user to open files and exit the program when finished and the Help button supplied the user with information on how to use the interface.

Using the Tcl language, the program was constructed so that when any section of the gaseous entry was selected the gas's name, comments, and temperature range(s) appear at the "Gases in Mixture" box followed by a separator line for clarification of different

gases. The chosen gas properties are also written to a separate file, called mixture.dat, that contains each gas that is to be included in the final mixture. A message is also sent to the status bar at the bottom of the window to let the user know that the gas was selected properly.

One of the original goals of this project was to install the program on the Internet for easy access. Unfortunately, the security rules of the Tk code do not permit putting the interface on the Internet due to some of the commands in the code. However, the next edition of Tcl/Tk might possibly allow this action and the interface will become accessible to everyone in need.

Results

The final product consists of a large window containing three separate boxes: one on the left to list each of the possible gases, one on the right to list each of the chosen gases, and one on the bottom to list the status of the running program. Initially, the window is totally blank. To view the database of gases, the data file must first be opened from the menubar. When opened, each of the possible gases will be listed in the left box. The user is then free to scroll up or down to find the appropriate gas or gases. When the desired gas is double-clicked, it is brought over to the selected gases box to let the user know that this gas will be included in the final mixture (Figure 1). The user is able to choose as many gases as desired and as many times as necessary. The Tcl and Tk code that performs these procedures can be seen in Appendix A. Each of these selected gases is also written to a separate file (see Appendix B), where it will be accessed later by another program, the Thermally Perfect Gas Code, that determines how this particular mixture of gases will actually behave.

Conclusion

This new interface has the same capabilities of the original FORTRAN code, but is

presented in a much easier to understand format. The boxes list exactly what gases there are to choose from, thus eliminating any guess work. Also, using the point and click method, there are fewer chances for the operator to make a mistake. And, because the interface was written in Tcl and Tk, any additions or revisions can be added with very little difficulty. Hopefully, this new program will become a welcome aid to anyone and everyone in need of it.

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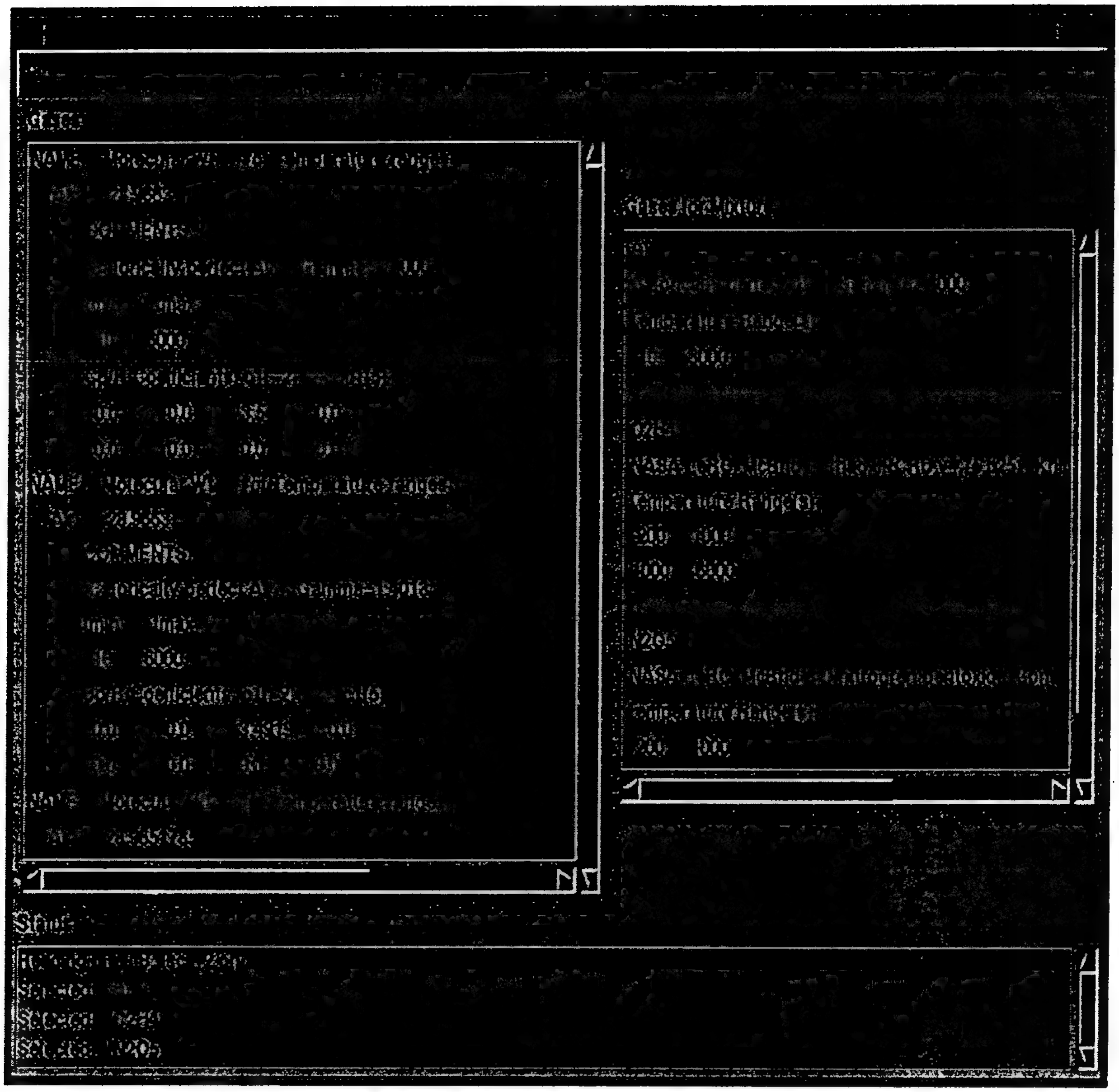
[3] Ousterhout, John K., Tcl and the Tk Toolkit. Addison-Wesley Publishing Company. Reading, Massachusetts; 1994 .

Figure 1



This picture shows the accessed database in the left box, the selected gases in the right box, and status of the program in the bottom box. As you can see in this picture, the selected gases for the artificial atmosphere are 'Air', 'C2H4', and 'N2O5'.

APPENDIX

Appendix A

The following pages show the code of the graphical interface.

```
#!/usr/local/bin/wish

#-----------------------------------------------------
#
# gas 0.1 - A gas mixture database generator
(Michael Munn)
#
#-----------------------------------------------------

set VERSION   0.1  # gtool version

#-----------------------------------------------------

wm title . "Gas database V$VERSION"

# Open output file

global out
set out [open "mixture.dat" w]

# Main window (wish)

# Menu bar

frame .menubar -relief raised -bd 2
pack .menubar -fill x
.menubar configure -bg lightgray

# Frames

frame .top
frame .bottom
frame .selected -relief flat -bd 2
pack .selected -anchor w

frame .gas -relief flat -bd 2
pack .gas

pack .top -side top
pack .gas .selected -in .top -padx 5 -side left

frame .status -relief flat -bd 2
pack .status -in .bottom -fill x -side bottom

pack .top .bottom -fill x -pady 2 -side top

# Gas area

label .gas.title -text "Gases" -anchor w
pack .gas.title -fill x

scrollbar .gas.yscroll -command ".gas.list yview"
pack .gas.yscroll -side right -fill y
.gas.yscroll configure -bg gray84

scrollbar .gas.xscroll -orient horizontal -
command ".gas.list xview"
pack .gas.xscroll -side bottom -fill x
.gas.xscroll configure -bg gray84

listbox .gas.list -relief groove -bd 2 -height 20 \
-width 55  -yscrollcommand ".gas.yscroll set" \
-xscrollcommand ".gas.xscroll set"
pack .gas.list -side left
.gas.list configure -selectborderwidth 3
.gas.list configure -bg gray88

#Selected area

label .selected.title -text "Gases for Mixture" \
 -anchor w
pack .selected.title -fill x

scrollbar .selected.yscroll -command \
".selected.list yview"
pack .selected.yscroll -side right -fill y
.selected.yscroll configure -bg gray84

scrollbar .selected.xscroll -orient horizontal \
-command ".selected.list xview"
pack .selected.xscroll -side bottom -fill x
.selected.xscroll configure -bg gray84

listbox .selected.list -relief groove -bd 2 -height \
15 -width 45 -yscrollcommand  selected.yscroll \
set" -xscrollcommand ".selected.xscroll set"
pack .selected.list -side right
.selected.list configure -selectborderwidth 3
.selected.list configure -bg gray88

# Status area

label .status.title -text "Status" -anchor w
```

```
pack .status.title -fill x

scrollbar .status.yscroll -command ".status.list \
yview"
pack .status.yscroll -side right -fill y
.status.yscroll configure -bg gray84

listbox .status.list -relief groove -bd 2 -height 4 \
-width 107 -yscrollcommand ".status.yscroll set"
pack .status.list -side left
.status.list configure -bg gray88

# File button

menubutton .menubar.file -text File -underline 0\
   -menu .menubar.file.menu
.menubar.file configure -bg lightgray

menu .menubar.file.menu
   .menubar.file.menu add command -label \
Open -underline 0 -command "readFile" \
  .menubar.file.menu add command -label Exit \
-underline 0 -command exit

# Help button

menubutton .menubar.help -text Help -underline\
0 -menu .menubar.help.menu
.menubar.help configure -bg lightgray

menu .menubar.help.menu
   .menubar.help.menu add command -label
Using -underline 0 -command {helpmsg}
   .menubar.help.menu add command -label
About -underline 0 -command {dialog .d
"About" "gtool V$VERSION\n\nby Bill Riner
(briner@edge.net) and Michael Munn" \
           {info} -1 OK}

# Load the menu bar

pack .menubar.file -side left
pack .menubar.help -side right

#--------------------------------------------------
# Binding to select gas

bind .gas.list <Double-Button-1> {
   set index [.gas.list curselection]

   set numgas [lookup $index]

# Write outfile

   for {set n 1} {$n <= $length($numgas)} {incr
n} {
      puts $out $globalgas($numgas,$n)
   }

   .selected.list insert end [lindex
$globalgas($numgas,2) 0]
   .status.list insert end "Selected:  [lindex
$globalgas($numgas,2) 0] "
   .selected.list insert end $globalgas($numgas,4)
   .selected.list insert end "Temperature
Range(s):"
  for {set n 1} {$n <= $length($numgas)} {incr\
n} {
      if [regexp {[0-9]+\.([ \t]+)[0-9]+\.}
$globalgas($numgas,$n)] {

         .selected.list insert end
$globalgas($numgas,$n)
      }
   }
   .selected.list insert end "----------------------"
}

# Send message to the status box

#--------------------------------------------------

proc lookup index {
    upvar length len

    incr index
    set ngas 1
    set totlen $len(1)
    while { ($index - $totlen -1) >= 0 } {
          incr ngas
          incr totlen $len($ngas)
    }
    return $ngas
}

#--------------------------------------------------

# Read database file

proc readFile {} {
   upvar globalgas gas
   upvar length len
   upvar max num
```

```
  # Get the filename

    set filename [openFilename]

    # Send a message to the status box

    .status.list insert end "Reading file $filename"

    # Read the grid file

#Read gas database and insert gases into gas box

    set f [open $filename]
    set n 0
    set i 0
    set l 0
    set num 0
    while {[gets $f line] >= 0} {

       if [regexp {^[0-9]+\-+} $line] {
          set i 0 ; incr n ; set l 0 ; incr num
          continue
       }
       incr i ; set len($n) $i
       set gas($n,$i) $line
    }
  close $f

    for {set n 1} {$n <= $num} {incr n} {
       for {set i 1} {$i <= $len($n)} {incr i} {
         if {$i == 1} {.gas.list insert end
$gas($n,$i) }
         if {$i == 2} {.gas.list insert end "
$gas($n,$i)" }
         if {$i != 1} {
             if {$i != 2} {.gas.list insert end "
$gas($n,$i)" } }
       }
    }
}

#---------------------------------------------------

# Filename list box for opening files

proc openFilename {} {
   global filename

   # Create the top-level window

   toplevel .open
   wm title .open Open
   wm iconname .open Open

   frame .open.top -relief groove -bd 2
   frame .open.bot -relief flat -bd 2

   # Listbox for file names

   listbox .open.top.files -relief sunken \
-borderwidth 2 -yscrollcommand
".open.top.scroll set"
   scrollbar .open.top.scroll -command\
".open.top.files yview"
   pack .open.top.scroll -side right -fill y
   pack .open.top.files -side left -fill x
   .open.top.files configure -selectborderwidth 3

#   set files [concat {. ..} [glob *]]
   set files [glob *]
   foreach i [lsort $files] {
      .open.top.files insert end $i
   }

   # OK button

   button .open.bot.button -borderwidth 3 -text
OK -command ""
   pack .open.bot.button -in .open.bot -side
bottom -expand 1 \
        -padx 3m -pady 2m -ipadx 2m -ipady 1m

   # Pack the toplevel window

   pack .open.top .open.bot -side top -fill x

   # Set the bindings

   bind .open <Return> {
     if {[selection get] != ""} {
        set filename [selection get]
     }
   }

   bind .open.bot.button <Button-1> {
     if {[selection get] != ""} {
        set filename [selection get]
     }
   }

   bind .open.top.files <Double-Button-1> \
             {set filename [selection get]}

   # Grab and focus
```

```
   set oldFocus [focus]
   grab set .open
   focus .open

   # Wait for a response, then restore the focus

   tkwait variable filename


   # Restore the focus

   destroy .open
   focus $oldFocus

   return $filename
}

#------------------------------------------------------

# Dialog box

proc dialog {w title text bitmap default args} {
   global button

   # Create the top-level window

   toplevel $w -class Dialog
   wm title $w $title
   wm iconname $w Dialog
   frame $w.top -relief raised -bd 1
   pack $w.top -side top -fill both
   frame $w.bot -relief raised -bd 1
   pack $w.bot -side bottom -fill both

   # Pack the top window with the bitmap and
message

   message $w.top.msg -width 3i -text $text
   pack $w.top.msg -side right -expand 1 -fill
both -padx 3m -pady 3m

   if {$bitmap != ""} {
      label $w.top.bitmap -bitmap $bitmap
      pack $w.top.bitmap -side left -padx 3m -
pady 3m
   }

   # Create the buttons

   set i 0
   foreach but $args {
      button $w.bot.button$i -text $but -
command "set button $i"
      if {$i == $default} {
         frame $w.bot.default -relief sunken -bd 1
         raise $w.bot.button$i
         pack $w.bot.default -side left -expand 1 -
padx 3m -pady 2m
         pack $w.bot.button$i -in $w.bot.default \
            -side left -expand 1 -padx 3m -pady
2m \
            -ipadx 2m -ipady 1m
      } else {
         pack $w.bot.button$i -side left -expand 1
\
            -padx 3m -pady 3m -ipadx 2m -ipady
1m
      }
      incr i
   }

   # Set the binding, grab, and focus

   if {$default >= 0} {
      bind $w <Return> "$w.bot.button$default
flash; \
         set button $default"
   }

   set oldFocus [focus]
   grab set $w
   focus $w

   # Wait for a response, then restore the focus,
and return the
   # index of the button

   tkwait variable button
   destroy $w
   focus $oldFocus
   return $button
}

#------------------------------------------------------

# Help window

proc helpmsg {} {

   toplevel .help
   wm title .help Using
   wm iconname  .help Using
 frame .help.top
```

```
}

frame .help.bot

text .help.top.text -relief groove -bd 2 \
  -yscrollcommand ".help.top.scroll set"
scrollbar .help.top.scroll -command
".help.top.text yview"
pack .help.top.scroll -side right -fill y
pack .help.top.text -side left

button .help.bot.button -text OK
pack .help.bot.button

pack .help.top -side top -fill x
pack .help.bot -side bottom -fill x

# Procedure to load the help file

proc loadFile file {
   puts $file
#      .help.top.text delete 1.0 end
   set f [open $file]
   while {![eof $f]} {
      .help.top.text insert end [read $f 1000]
   }
   close $f
}

# Load the helpfile

loadFile "gas.hlp"

# Set the binding, grab, and focus

bind .help <Return> \
  ".help.bot.button flash; set button OK"
bind .help.bot.button <Button-1> \
  ".help.bot.button flash; set button OK"

set oldFocus [focus]
grab set .help
focus .help

# Wait for a response, then restore the focus,
and return the
# index of the button

tkwait variable button
destroy .help
focus $oldFocus
}
```

Appendix B

The following lines show the result of running the interface. This file is called "mixture.dat"

```
NAME:  Molecular Wt.   #of Temperature ranges
'Air'   28.9663        1
COMMENTS:
'Calorically perfect Air - Gamma=1.4000'
tmin    tmax
 10.    6000.
Cp/R Coefficients: c1(-2) --> c1(5)
 0.0      0.0      3.5      0.0
 0.0      0.0      0.0      0.0
NAME:  Molecular Wt.   #of Temperature ranges
'C2H4 '  28.05376       2
COMMENTS:  (LeRC ID=1 1/91)
'NASA LeRC, McBride: Chao,JPCRD,v4,75,p251. Knippers,Ch.Phys,v98,85,p1. TRC.  '
 tmin    tmax
 200.   1000.
Cp/R Coefficients: c1(-2) --> c1(5)
 -1.16361327D+05 2.55486052D+03 -1.60975030D+01 6.62578637D-02
 -7.88508639D-05 5.12522379D-08 -1.37033846D-11 0.00000000D+00
 tmin    tmax
 1000.   6000.
Cp/R Coefficients: c1(-2) --> c1(5)
  3.40872512D+06 -1.37483642D+04 2.36588483D+01 -2.42372856D-03
  4.43116915D-07 -4.35234840D-11 1.77521829D-15 0.00000000D+00
NAME:  Molecular Wt.   #of Temperature ranges
'N2O5 ' 108.01048       2
COMMENTS:  (LeRC ID=1 4/90)
'NASA LeRC, McBride: Dinitrogren pentoxide. Cons & Hf298: TPIS,v1,pt1,1989.  '
 tmin    tmax
 200.   1000.
Cp/R Coefficients: c1(-2) --> c1(5)
  4.00833058D+04 -8.77043317D+02 1.05597757D+01 1.39448310D-02
 -8.88233080D-06 8.48487723D-10 7.79627137D-13 0.00000000D+00
 tmin    tmax
 1000.   6000.
Cp/R Coefficients: c1(-2) --> c1(5)
 -5.32410795D+04 -3.10932181D+03 2.03609435D+01 -9.96022986D-04
  2.40150274D-07 -3.05732334D-11 1.49601157D-15 0.00000000D+00
```

INTRANET DEVELOPMENT PROBLEM WITH POWERPOINT

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Final Report for:
High School Apprenticeship Program
Arnold Engineering and Development Center

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Arnold Engineering and Development Center

August 1997

INTRANET DEVELOPMENT PROBLEMS WITH POWERPOINT

Jason A. Myers

Introduction

The need for cost-effective intra-business communications has spawned many new ideas, and one of the best is Intranets. Intranets provide a user-friendly way to share information; however, the creation of an Intranet can be a difficult task. To ease the developers in this task there are many software products available that make Intranet development as easy as using a word processor. There are also products that somewhat ease difficult programming. Development may also be accomplished by programming languages, such Java, Visual Basic, and JavaScript. There are many ways that Intranets may be developed and most involve a blend of structured programming languages and advanced software.

Discussion of the Problem

An excellent way to present data is in the form of a chart or graph, and to do this many people use PowerPoint. PowerPoint allows them to group charts or graphs into a presentations; however, it presents a problem when you wish to move the presentation to the Internet. That is problem is the lack of an efficient and user-friendly way to make the transition. Microsoft realized this and created a built in function to accomplish this task in PowerPoint 97. There are few effective ways for Intranet developers to incorporate presentation into web pages.

Methodology

We evaluated several methods of incorporating presentations in to web pages. We tested pure HTML and GIFs[1], different software products, and checked news groups for answers. The software tested included Microsoft FrontPage, PowerPoint 97, Visual InterDev, and Visual J++. Alt.comp.dev.intra and intra.comp.sys.dev.news were contacted to see if anyone else had experienced and solved the same problem. To find a way to incorporate PowerPoint presentations into web pages we tried many avenues of information and software.

[1] Graphic Image Formats

When testing pure HTML and GIFs, we tested HTML 2.0 and 3.0, and also used 89a[2] format and standard format GIF files. During FrontPage testing we used the standard page setup; however, we did not use the wizards. In PowerPoint we tested the save as HTML feature, which generates HTML codes and saves the presentation in an unknown GIF format. Visual InterDev allowed see the results of Javascripting and Visual Basic scripting the presentation into the web pages. With Visual J++ we created an applet to show the PowerPoint presentations on slide at a time as an image. The news groups had no ideas or software that would ease the incorporation.

Results

First we tested HTML 2.0 with Microsoft Internet Explorer and both types of GIFs. With the 89a GIFs, it had a superb load time; however, the image was unreadable. This was due to the transparent background. The standard GIFs set white as the background color and the graph was readable, but the load time was far longer than desired. Trying to combat this problem, we reduced the size of the image to a size where it was still readable, and reloaded the page. The load time was still unacceptable and this idea was abandoned. HTML 2.0 was not the solution to our problem.

HTML 3.0 offered advanced graphic handling ability, so it was tested with both types of GIFs. Upon test HTML 3.0 with 89a GIFs, we found that the image quality[3] and load times were acceptable but mediocre. With standard GIFs, our results were much worse. Even at low image quality the load time was still high and the loading of the page almost ceased when the image started. Resizing the images had little positive effect on the image load speed. Even with advanced features HTML 3.0 did not eliminate our problem. During Microsoft FrontPage testing we were limited to certain predefined positions, such as right, left, center. Although we were not allowed to move objects around on the page well, the image quality and load speed was at acceptable levels. The only way to edit the pages was through FrontPage and this presented another problem. That problem was the fact that when these presentations were updated we had to use FrontPage to update the image. Even though FrontPage's results were acceptable we decided that the editing procedure was to difficult to do on a monthly basis.

---

[2] Format 89a is a GIF image that can have a transparent background and has a load time faster then that of a standard GIF.

Next, we tested Microsoft PowerPoint using the "save as HTML" feature[4] in Office 97. This feature generates the HTML and store the images in an unknown GIF format. Again, we had no control of the position of the image. The load time and image quality were both acceptable. The only drawback was that the program created lots of subdirectories to accomplish its' task. This eliminated it as a reasonable choice due to memory constraints.

Visual InterDev, Microsoft's latest web development tool, failed due to the fact that is requires a very powerful machine to run on. However, we did test it and it produced more than acceptable results. We had full control with a powerful way to edit and update images. If a whole machine and operator were devoted to Intranet development this would have done the job perfectly; however, no one person has the machine nor the time required to learn Visual InterDev. So Visual InterDev was no longer a plausible idea.

Java[5] offered a unique approach to the incorporation. It allowed us to broadcast the presentation like it was delivered. Java's main drawback was the amount of time necessary for updating the images. It also only worked for an unknown reason in Microsoft Internet Explorer. Without a universal way to view the presentation we chose to remove Java as an effective method.

As a last resort we experimented by using Microsoft FrontPage as the generator, writing HTML positioning code, and using the images from the PowerPoint "save as HTML" tool. This produced excellent results. Load time was lower than all other options and image quality was greater than all other options, but perhaps the most important part was the ease of updating images and creating more presentations. We had created a template that could be update just by naming the new image what the old one had been. This made monthly updates as simple as renaming a file. Using the best parts of every product produce good results.

Conclusion

Effective communication lies within the desire to produce results that are user-friendly and cost-effective. To achieve the high image quality and lowest load time desired, one must use a mixture of tools and skills. As Intranet communications develops more problems shall arise and be overcame by those who challenge

---

[3] Refers to image resolution

[4] In Microsoft Office 95 you must download the Internet Assistant to use this feature.

what is accepted. Already database incorporation is a big issue, but that too has been solved with a mixture of tools. Problems in Intranet development must be tested and proven to produce a product that is useful to the user.

[5] All Java applets were built in Visual J++.

ASSESSMENT OF REFLECTING MICROWAVE HORN DATA WITHIN A PLASMA

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Final Report for:
High School Apprenticeship Program
Arnold Engineering Development Center

Sponsored by:
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August 1997

ASSESSMENT OF REFLECTING MICROWAVE HORN DATA WITHIN A PLASMA

James Peter Nichols
Tullahoma High School

Abstract

Burning of rocket exhaust gasses generates free electrons. These free electrons can disrupt communication signals. In order to quantify this disruption, determination of plasma properties (e.g. electron number density) must be made. A microwave experiment was developed where microwaves are propagated through a plume during rocket motor tests and the transmission of the microwave beam is measured. There are two methods available to determine electron number density from transmission data. One method assumes the plasma properties vary smoothly; the adiabatic method. The other method assumes sharp plasma boundaries and accounts for internal reflections; the coherent method. In this paper, calculations are made using both methods, and the implications of each method are discussed.

ASSESSMENT OF REFLECTING MICROWAVE
HORN DATA WITHIN A PLASMA

James Peter Nichols

Introduction

Burning of rocket exhaust gasses generates free electrons. These free electrons can disrupt communication signals. In order to quantify this disruption, determination of plasma properties (e.g. electron number density) must be made. A microwave experiment was developed where microwaves are propagated through a plume during rocket motor tests and the transmission of the microwave beam is measured. There are two methods available to determine electron number density from transmission data. One method assumes the plasma properties vary smoothly; the adiabatic method. The other method assumes sharp plasma boundaries and accounts for internal reflections; the coherent method. In this paper, calculations are made using both methods, and the implications of each method are discussed.

Discussion of Problem

A typical microwave transmission experiment propagates microwaves in a focused beam through a plasma (see figure 1). A model of adiabatic microwave transmission is given by the expression $T = -\alpha d$ (see figure 2).

Methodology

In order to approach this problem, it was decided to use C programming to write a program to do the calculations. Time was spent in studying C and learning how to use it. A program was then written to calculate and write microwave attenuation data. The program was written to calculate using typical rocket motor conditions. The program was then modified to calculate with and without interference conditions. The results were then plotted using Microsoft Excel.

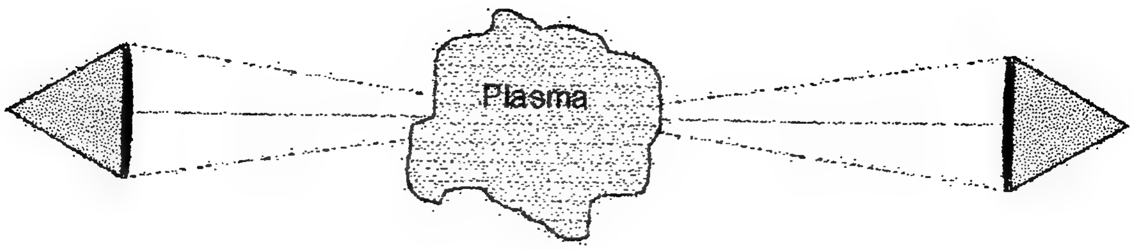

Figure1 – This figure exemplifies the typical experiment arrangement. The source horn sends out the microwaves in a focused beam through the plasma. The plasma interacts with the beam and the signal attenuation is measured.

$$T = {}^{E_r}/_{E_o} = e^{-\alpha d},$$

$$\alpha = \alpha(n_e, \nu, \omega)$$

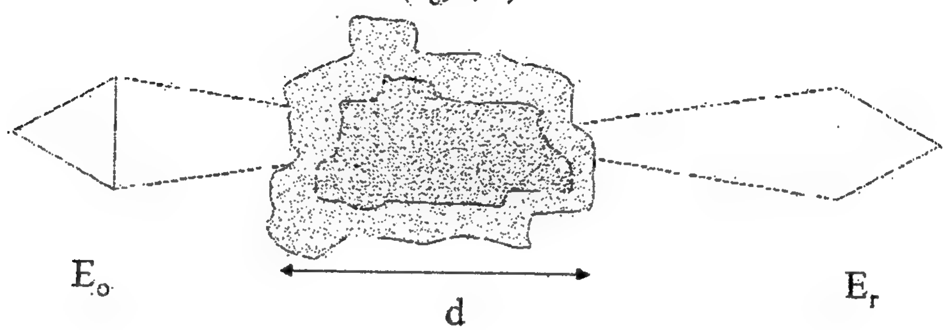

figure 2 – This figure exemplifies an adiabatic plasma. The two tones represent a smooth variation of plasma properties. Because of this smooth variation, reflection and interference are ignored.

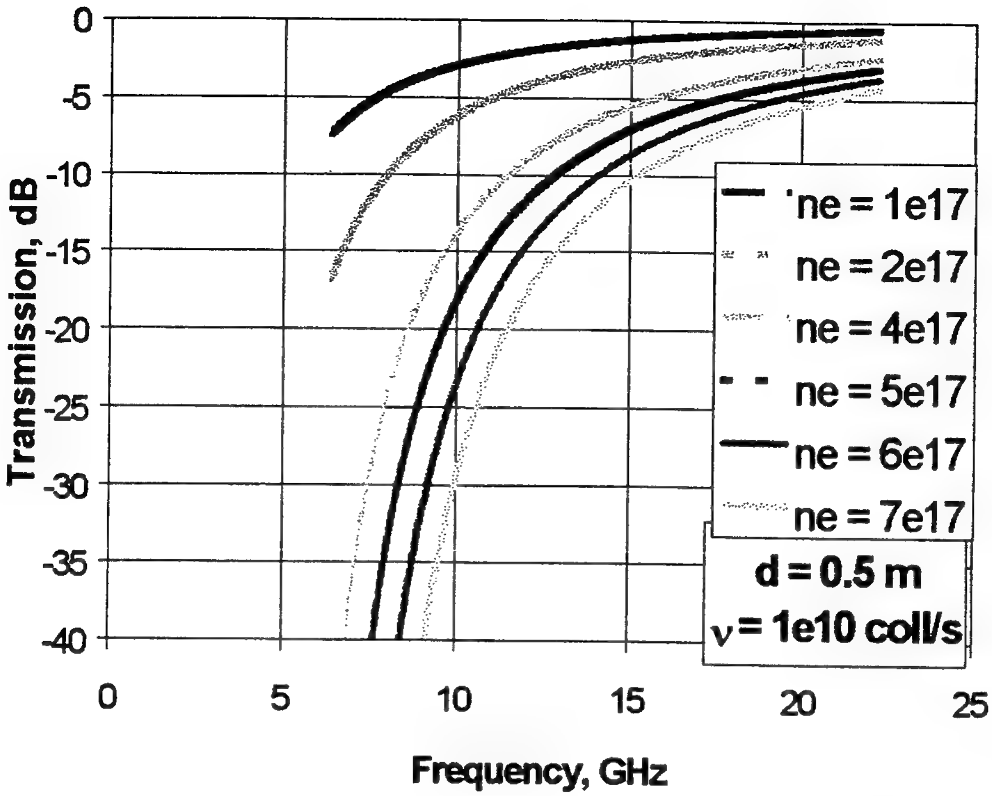

figure 3 – This plot contains adiabatic curves for number densities 1e17 to 7e17. The transmission increases with frequency and decreases with number density.

$$T = \frac{\left\{\left[(1-r)^2 + 4r\sin^2\psi\right]\exp(-2\alpha d)\right\}}{\left\{\left[1 - r\exp(-2d\alpha)\right]^2 + 4r\exp(-2\alpha d)\sin^2(\beta d - \psi)\right\}}$$

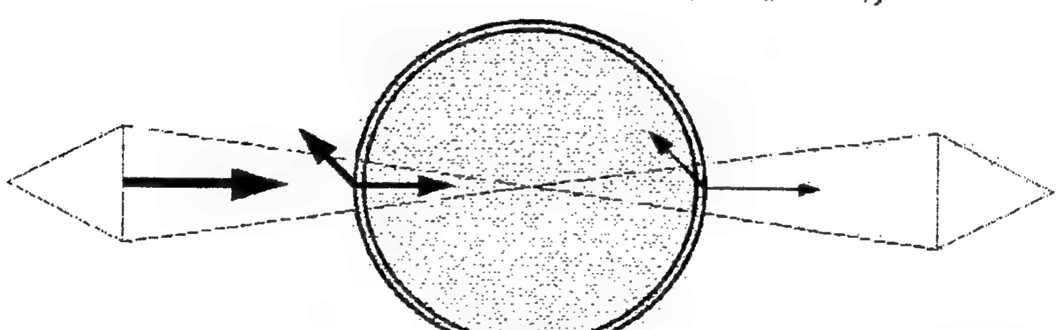

figure 4 – This figure is an example of a coherent plasma. The double lines exemplify sharp plasma boundaries that can occur. In this equation and figure include internal reflections and interference effects.

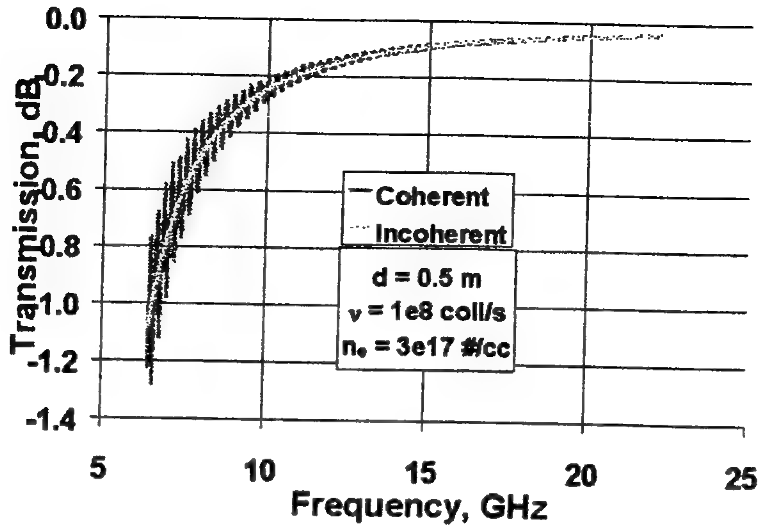

figure 5 – This plot shows coherent and incoherent transmission (in dB). The collision frequency of 1e8 is too low for rocket plumes but is used to show interference effects.

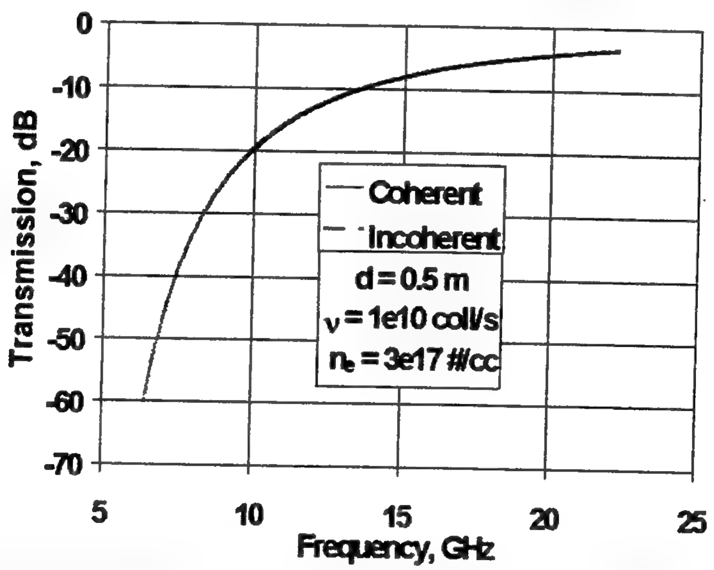

figure 6 – This p[lot shows coherent and incoherent transmission for 1e10, which is a much better collision frequency for rocket plumes. The interference effects are not evident in this plot.

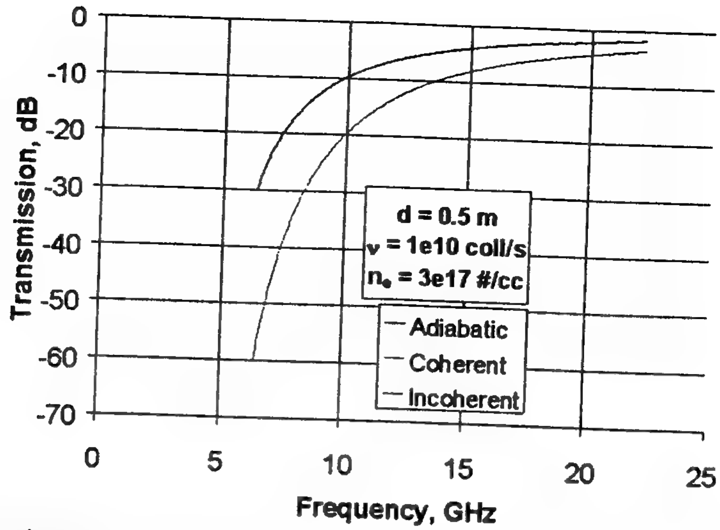

figure 7 – This transmission includes both adiabatic and coherent/incoherent transmission plots. Coherent shows less transmission than adiabatic. Coherent also accounts for reflection losses that are not accounted for in adiabatic.

Computer Manipulation of Raman Spectroscopy Test Data

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Final Report of:
High School Apprentice Program
Arnold Engineering and Development Center

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Arnold Engineering and Development Center

August 1997

COMPUTER MANIPULATION OF RAMAN SPECTROSCOPY TEST DATA

BY
JAMES PERRYMAN

ABSTRACT

Aerodynamics, the study of fluids and their resultant forces, has experienced significant advancements in the past twenty years. Yet, there is still much left to uncover. Computational Fluid Dynamics(CFD) attempts to logically determine the fluid properties of a model for given flow conditions. The advantages of this technique are the huge savings in time and money over a traditional tunnel based test system. No equipment is required, because the flow is calculated and simulated with mathematics on a computer. CFD has the potential to greatly enhance aerodynamics testing, enabling man-hours to be spent investigating new frontiers. CFD's success depends on the accurate modeling of even the most minute flow characteristics. Since CFD is only an estimation, the need for concrete, precise CFD solutions was recognized early on. The project focuses on this data acquired from tests initiated many years ago. These tests eventually included two models, a zero base and a broad base, each with an air-jet test, a hydrogen-jet test, and a combustion-jet test. During these tests, various optical techniques were applied such as LDV, LIF/Raman spectroscopy, vaporscreen, shadowgraph, interferogram, Schlieren, etc.

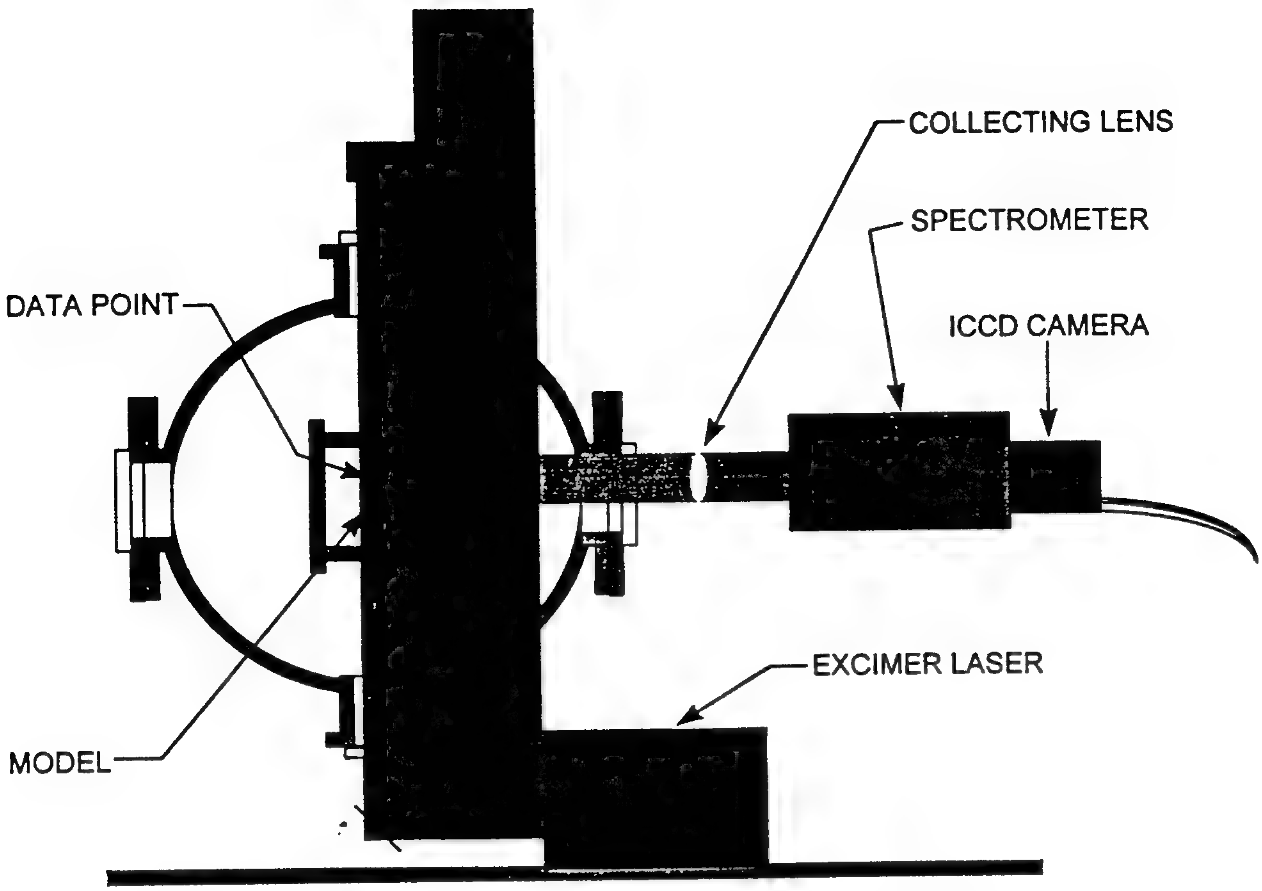
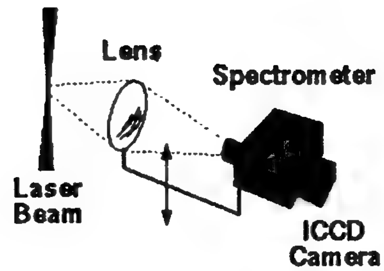


Fig. 1 Raman Spectroscopy

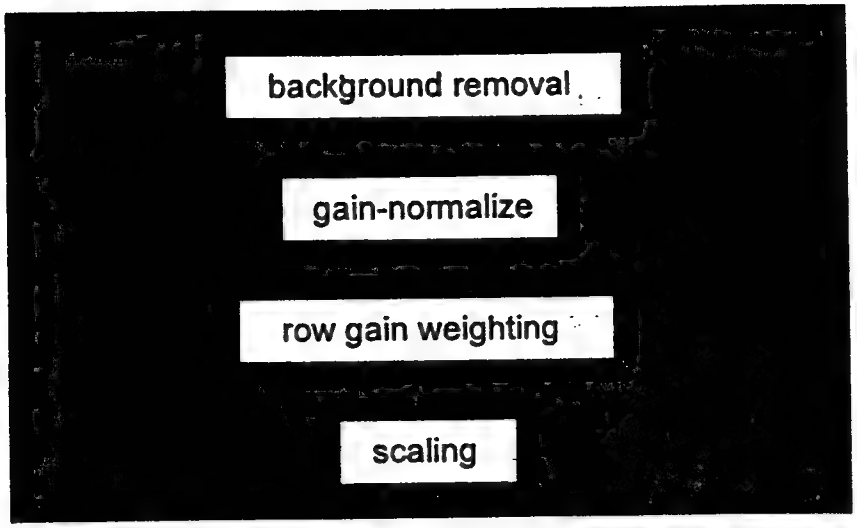
The project focuses on the LIF/Raman data from the tests. Both LIF and Raman processes return data on the luminescence of molecules after excitement by a laser source. In the project, various substances occur such as H and O from the fuel rich mixture, OH and H20 from the H2/O2 combustion, and N2 from the outside air that provides the flow.



In a test situation, a laser excites the molecules at the data point, causing them to fluoresce accordingly. The fluorescence is focused onto the slit of a spectrometer and then onto an ICCD digital camera. The original laser light is subtracted and the quantized output is written in some graphics file format, in this case an SPE file (Fig. 2).

Fig. 2 SPE file

Depending on the calculations used, Raman data can yield the density or the temperature of the data point. The project goal is to successfully interpret the SPE file, subtract the camera background, gain-normalize the data, scale the data to a specified range, and produce visual representations for each data manipulation.



The SPE file was read into four 578 wide arrays. Each of these arrays represent one row of data from the spectrometer. The intensity of the pixels in the image is the luminosity of the molecules at the focused region. The luminosity at certain bands of the spectrometer image must be summed in order to yield the calculations (Fig 4). To get correct results, the background caused by noise in the camera during the integration time must be subtracted (Fig. 5). The second step is gain-normalization achieved by multiplication of each value by a constant gain recorded on test day. Next the data is adjusted to compensate for row weighting. After the manipulations, the data is scaled to maximize contrast, and a plot of wavelength vs. luminosity is written to an SGI RGB file (Fig 3).

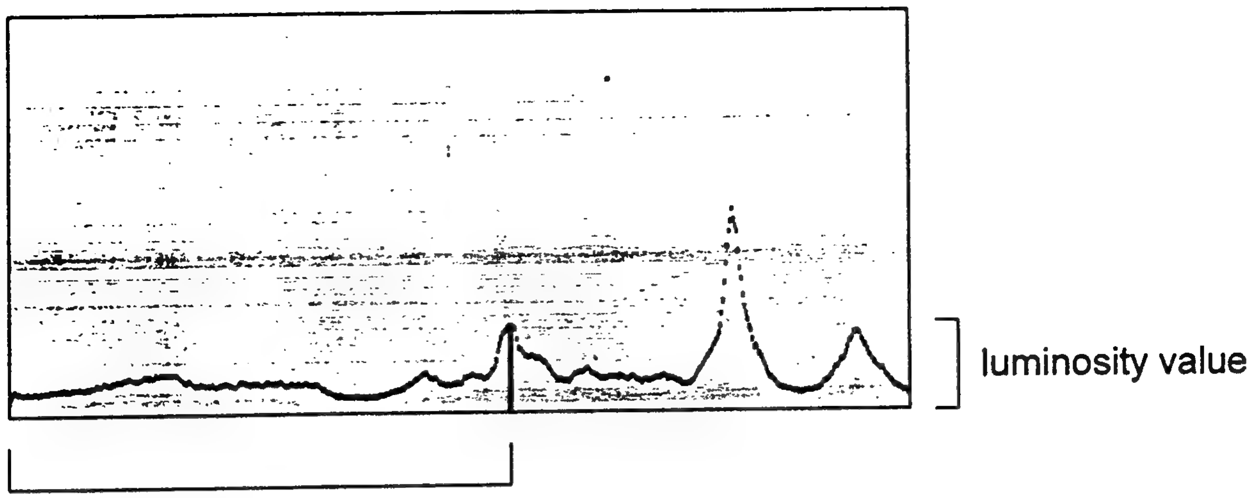


Fig. 3

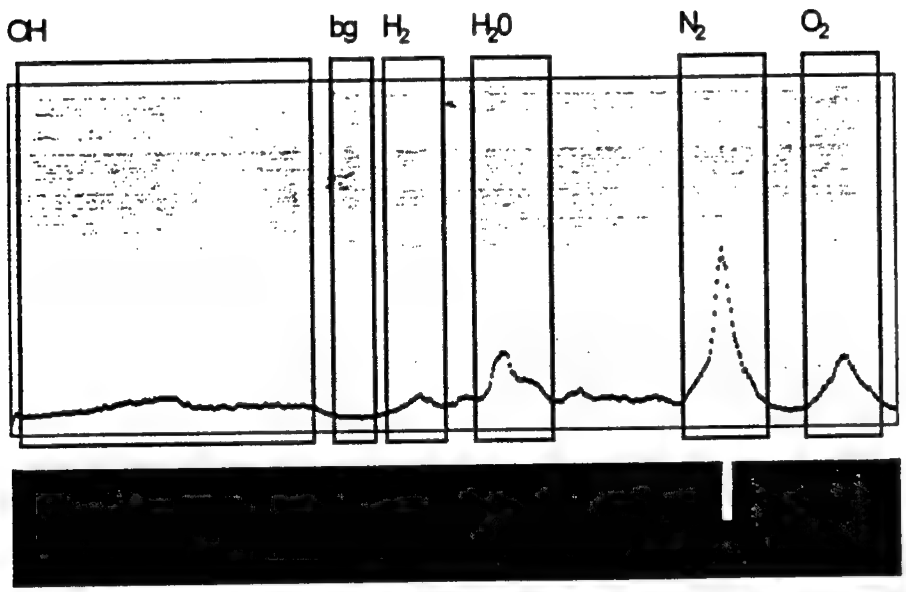


Fig. 4 bands

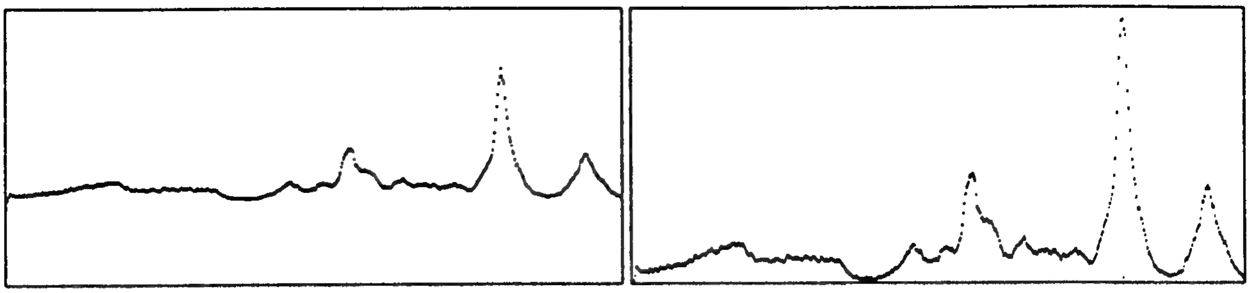


Fig. 5

In order to create the plots, a C function was written. The code was also designed to produce different plots according to command line parameters. One of the difficult sections of the project was fusing the different pieces of code that do the respective array manipulations, plotting, and command line parsing.

Conclusion

The primary goal of the project was to perform various data manipulations on data from Raman spectroscopy analysis of wind tunnel flow. The project involved writing a C program to do the operations and create text files and charts to better analyze the density and temperature of the flow. After a brief debugging period, success was attained. The program seamlessly enhances the quality and clarity of the data and vastly improves the efficiency of the process.

References

1. Russ, John C. *The Image Processing Handbook.* CRC Press, Inc., Boca Raton, 1992.
2. John, James E. A. *Gas Dynamics*. Allyn and Bacon, Inc., Boston, 1969.
3. Walker, B. J. and Heltsley, F. L. *Nonintrusive Diagnostics of Supersonic Missile Afterbody Flows*. ICIASF 1993.

EVALUATION OF ARC HEATER PERFORMANCE AND OPERATIONAL STABILITY

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Final Report for:
High School Apprentice Program
Arnold Engineering Development Center

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Arnold Engineering Development Center

July 1997

EVALUATION OF ARC HEATER PERFORMANCE AND OPERATIONAL STABILITY

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ABSTRACT

Because of the requirement for high pressure segmented arc heaters with a larger testing capacity, operational characteristics over a wide range of variables must be understood. There is a need to expand the range of this knowledge in order to understand arc heater operations and to assist in the design of future arc heaters. This information can be expanded by using data correlations, comparing module wall heat flux profiles, and establishing operational stability criteria for existing and future high enthalpy segmented arc heaters. By using large nozzle throat diameter data in data correlations, the range of information is extended, and existing information is improved. The comparison of module wall heat flux profiles provides insights into the effect of various test conditions on heater operation; a larger throat size dramatically increases the module wall heat flux in the downstream portion of the heater. Operational stability limits and acceptable guidelines are now available for large throat diameter runs.

EVALUATION OF ARC HEATER PERFORMANCE AND OPERATIONAL STABILITY

Kristin A. Pierce

INTRODUCTION

Hypersonic testing requirements for propulsion, materials, and structures dictate high pressures and temperatures not attainable by conventional means. Therefore, electric arc heaters are the only viable method to achieve high temperatures to simulate atmospheric reentry conditions for test durations of several minutes. Arc heaters have been used to great success in both aeronautical and industrial testing.

An arc heater is an apparatus that uses a continuous electrical discharge to heat air to very high temperatures. An arc is stretched down the length of the constrictor from an anode to a cathode (Fig. 1). Air is forced through the constrictor and becomes heated by the electric arc. The configuration of the standard AEDC H1 arc heater includes a heater constrictor which is made of nearly 200 copper segments that are insulated from each other, preventing the arc from traveling down the wall of the constrictor. Air is injected tangentially to the inside wall to create a vortex to help stabilize the arc. Water is pumped internally through the copper segments to prevent them from melting. The arc heated air is expanded through a supersonic nozzle onto test models to simulate the high enthalpy conditions experienced during flight. The standard AEDC H1 arc heater configuration uses eight groups of 24 copper segments each (column modules) and a nozzle throat diameter of 0.9 in. as shown in Fig. 2.

Because of the requirement for high pressure segmented arc heaters with a larger testing capacity, operational characteristics over a wide range of variables must be understood. There is a need to expand the range of this knowledge in order to understand arc heater operations and to assist in the design of future arc heaters. Due to the diversity in today's missiles and aircraft, different sizes of arc heaters are needed to test the conditions these devices can tolerate. As missiles and aircraft grow larger, so must the test facilities they utilize. To design and build these larger arc heaters, information must be gathered from existing heaters and understood by the personnel who gather the data.

DISCUSSION OF PROBLEM

Large data bases must be compiled that represent the widest possible range of conditions for arc heater performance. To contribute to this operational data base, arc heater runs with a large throat diameter (D*=1.156 in.) were added to observe their effect on certain aspects of heater behavior. The data was correlated and plotted to present a clearer picture.

In addition to data base correlations, local parameters, such as wall heat flux, can be evaluated to expand the knowledge of heater behavior. Once this information is plotted, it gives a clear indication of the effect of various conditions on heater activity. A comparison of some heater conditions can also establish operational stability criteria for existing arc heaters and prevent potential mishaps while a heater is operating.

All of these factors -- data base correlations, local parameters, and operational stability criteria -- yield a greater understanding of heater operations. They will assist in the operation of existing heaters and help in the design of future heaters.

METHODOLOGY

Correlations were developed to examine global parameters of arc heaters: pressure, voltage, bulk enthalpy, and mass flow. There were existing data bases containing both H1 conditions only and H1 data combined with data from other heaters. Two data bases were used because an exclusive picture of H1 performance was desired, but a more general picture of arc heater performance was also necessary.

The data bases were correlated using a data correlation computer program that generates a coefficient and exponents in a power equation of the form

$$y = k(x_1)^{n_1}(x_2)^{n_2}(x_3)^{n_3}\ldots$$

where y is the parameter to be correlated, coefficient k and exponents n_1, n_2, n_3, . . . are generated by the correlation program, and x_1, x_2, x_3, . . . are measured input parameters from the data base selected. The coefficient and exponents are generated by the program to minimize the root-mean-square (RMS) error in the parameter, y, to be correlated.

In order to provide additional scaling law and performance data as a function of nozzle throat diameter, the nozzle throat diameter was increased from 0.9 in. to 1.156 in. This large change in throat size can have a profound effect on the basic arc heater operational stability. Raw data, which included six runs with a large nozzle throat diameter (1.156 in.), were added to an existing 41 point data base. This set of 47 data points, the HEAT-H1 data base, was chosen in order to correlate arc heater performance with throat diameter as a variable. The purpose was to extend the range of the existing data base to include the large throat diameter data.

A set of 91 data points was selected from three segmented arc heaters in order to provide a wider range of variables than with the previously mentioned 47 point data base. The purpose of the additional data correlations with the extended data base was to add new operational data with the large nozzle throat diameter (1.156 in.) and data from two other arc heaters of a smaller bore diameter, to extend the range, improve the correlations, and provide scaling relations for future arc heater operations. Forty-seven of the data points are described as the HEAT-H1 data base. The remaining data were taken from other small heaters.

Wall heat flux is monitored to insure that design limits on an arc heater are not being exceeded. As the operational envelope is extended to high pressure and current, the wall heat flux will dramatically increase, further increasing the need to carefully measure the segment heat load. In order to determine the wall heat flux during operation, experimental measurements of the cooling water temperature rise and mass flow rate are made. These measurements are then used to calculate wall heat flux.

Comparisons were made of the 1.156 in. throat diameter runs and smaller 0.9 in. throat diameter runs at similar conditions. The large throat diameter to small throat diameter comparison will provide some insight into the dependence of throat diameter on wall heat flux at similar operating conditions. Also, four large throat runs were compared with each other to observe the effects of mass flow on wall heat flux.

In order to determine the lower limits of arc heater operation with the large throat configuration in terms of arc stability, arc current and air mass flow rate were used to present the large throat diameter data as a function and determine operational stability criteria.

RESULTS

In the forty-seven point data base correlations, RMS errors ranged from 1.484% to 6.577%. Some of the plotted correlations are presented in Figs. 3 through 6. Considering the relatively small input data set, the numbers of variables and the wide range of values of the various parameters, the data scatter was very small. In the correlations available from the larger ninety-one point data base, RMS errors ranged from 2.121% to 7.436%. Examples of these correlations are presented in Figs. 7 through 10. Data scatter for these correlations was also very small.

Wall heat flux for four large throat diameter (D*=1.156 in.) runs was compared with that from the standard nozzle throat diameter (D*=0.9 in.) runs from previous tests at similar chamber pressure and arc current conditions. Some of the runs compared are presented in Fig. 11a. Notice that the wall heat flux profiles of the two runs with different throat diameters exhibit similar characteristics. The runs with the large throat diameter start at a comparatively equal level as the standard throat diameter runs in modules 8 through 4, but downstream of module 4 the wall heat flux rises much more rapidly. This is thought to be due to the much larger throat size, which results in a higher mass flow, higher gas velocities, and lower enthalpy, which creates more turbulence. The large throat size may perhaps cause the vortex flow to burst or become unstable, promoting more mixing of the hot gas in the core with the colder gas injected between the segments on the heater wall. In Fig. 11b, four of the runs using a large throat diameter nozzle were compared with each other. The runs are shown in order of increasing mass flow; the run at the highest level of wall heat flux has the highest mass flow, and the run at the lowest level has the lowest mass flow.

As a guideline for determining stable heater operating conditions, one plot is presented in Fig. 12. Figure 12 presents the H1, large-throat, steady-state data as a function of arc current and air mass flow rate. Two runs were operated in an unstable mode with a blown arc, an indication of arc instability resulting in a condition where the electric arc is physically blown out of the nozzle and is visible in the flow field of high temperature air. An operational stability line was drawn between these two data points with heater operation considered stable above the line and unstable below the line.

The guidelines described in the above paragraph and in Fig. 12 were compiled for the H1 arc heater only with a 1.156 in. nozzle throat diameter. Different throat sizes will result in different stability plots.

CONCLUSION

Expansion of existing data bases is important to further the understanding of arc heater operation. A standard eight module H1 arc heater was configured with a large nozzle throat diameter and operated at various chamber pressures and arc currents to determine operational stability and to improve arc heater scaling relations.

The results of this test were added to existing data bases and used to extend the available range of data in these data bases. Arc heater performance parameters with the larger nozzle throat diameter incorporated in the data base were correlated to obtain new relationships for air mass flow, enthalpy, voltage, and chamber pressure. The correlation data scatter was relatively small, indicating a good fit to the earlier heater data.

A comparison of wall heat flux between large throat (D^*=1.156 in.) and standard throat (D^*=0.9 in.) runs at similar operating conditions showed that the wall heat flux increases more rapidly in the downstream portion of the heater with the large throat probably because of the higher mass flow and greater mixing of the hot and cold air bringing more of the hot gas in contact with the heater walls.

The operational stability limit was established for an eight module heater with a 1.156 in. nozzle throat diameter. Guidelines were established for acceptable limits of arc current versus air mass flow.

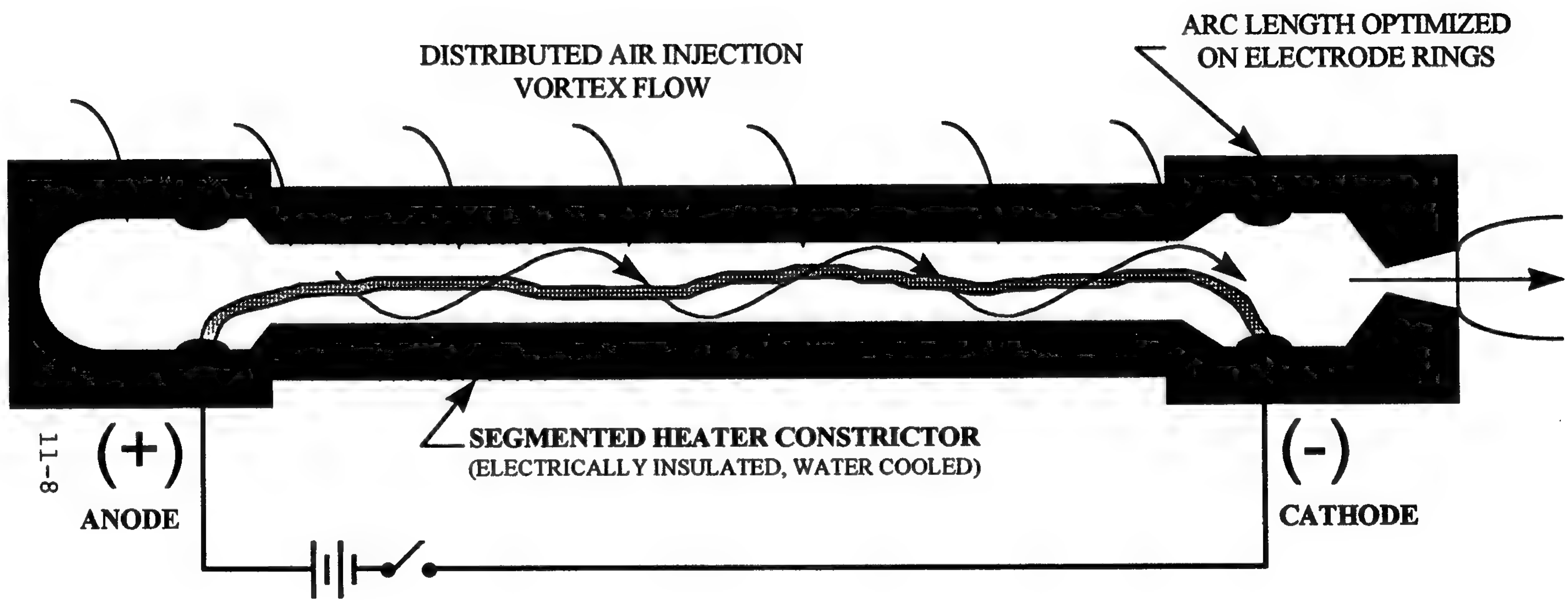

Figure 1. Segmented Arc Heater Operational Characteristics.

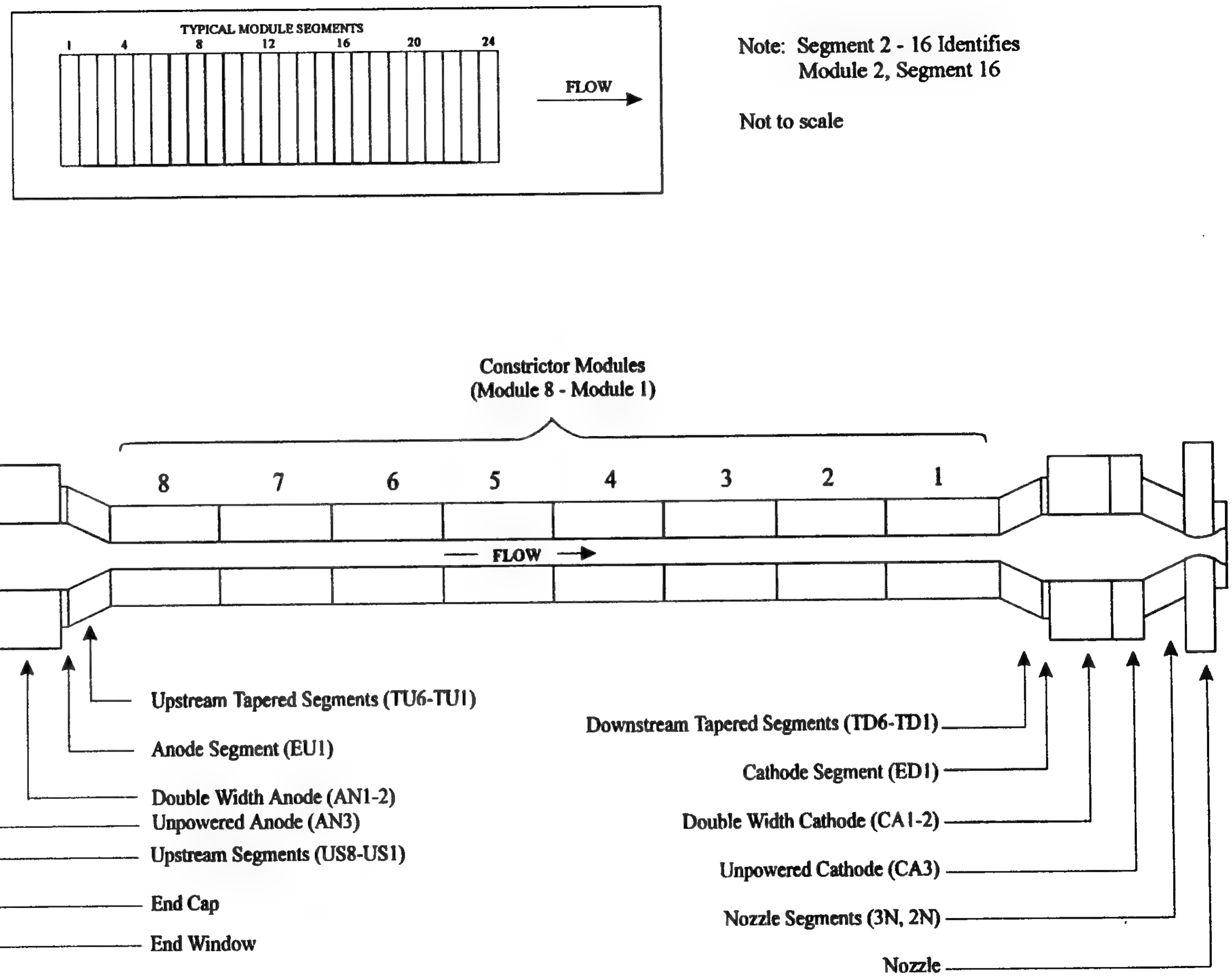

Figure 2. H1 Component Designation and Relative Locations.

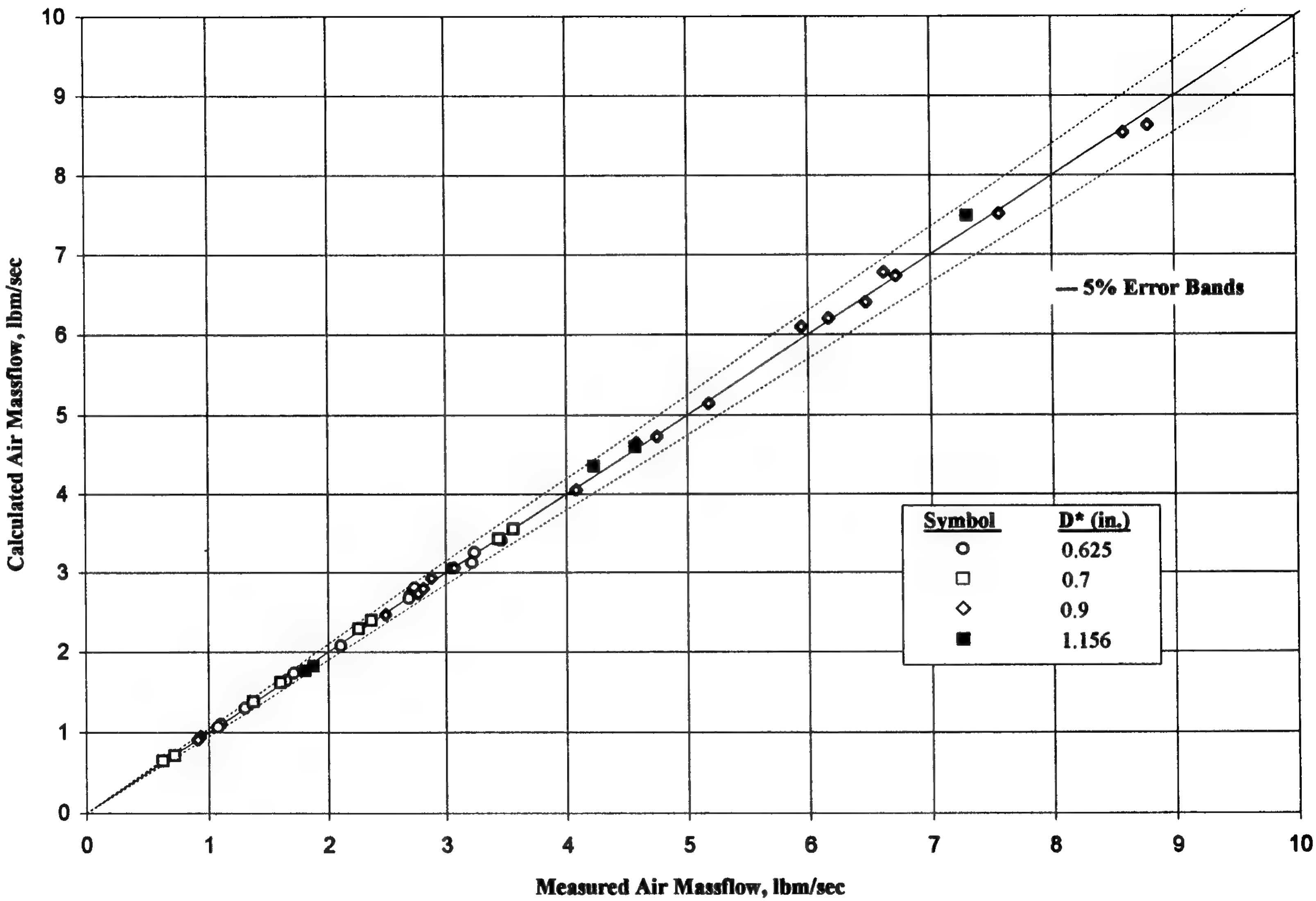

Figure 3. Calculated versus Measured Equilibrium Sonic Mass Flow for the H1 Data Base for Various Throat Diameters (D*).

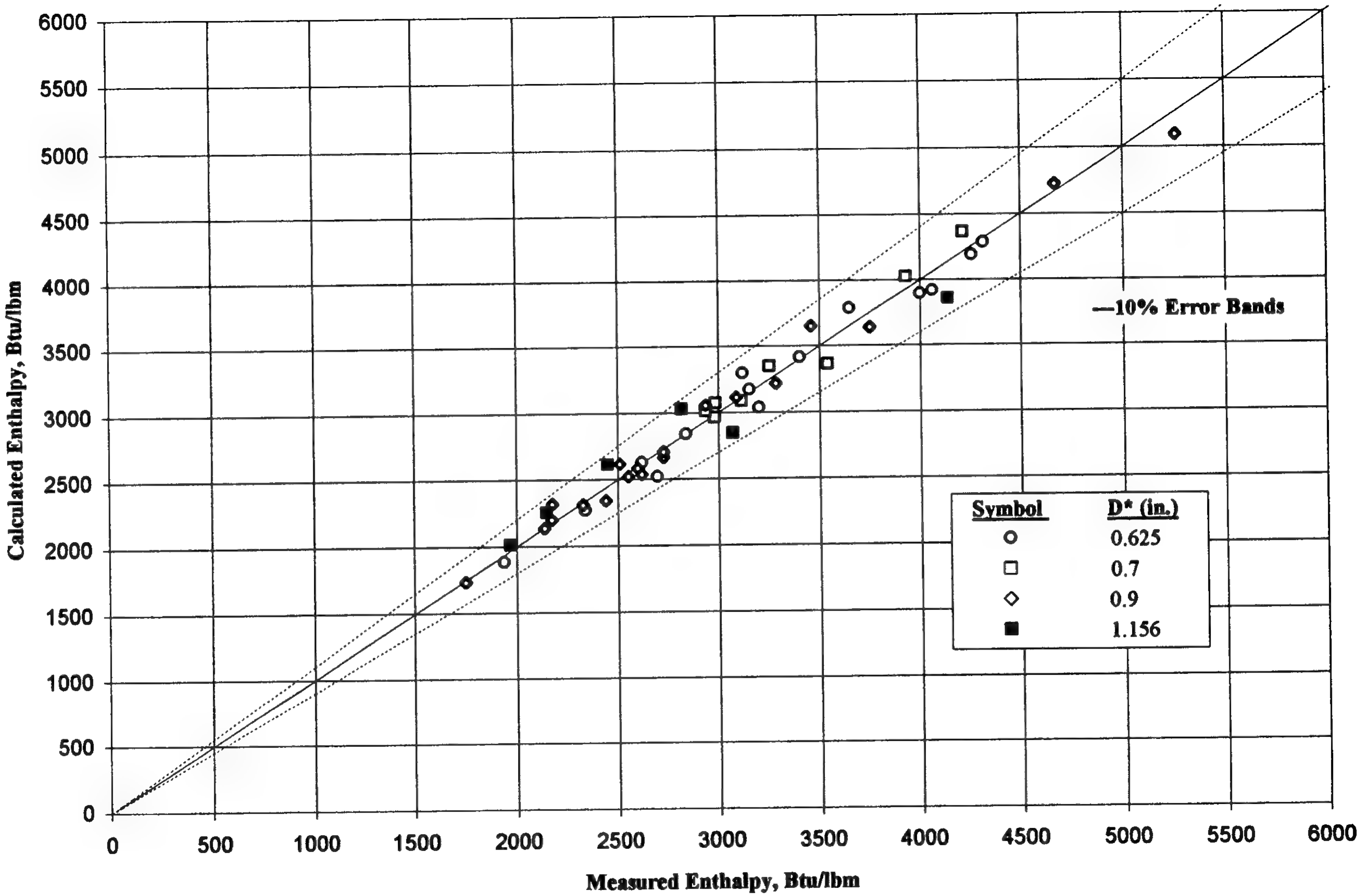

Figure 4. Calculated versus Measured Equilibrium Sonic Flow Enthalpy for the H1 Data Base for Various Throat Diameters (D*).

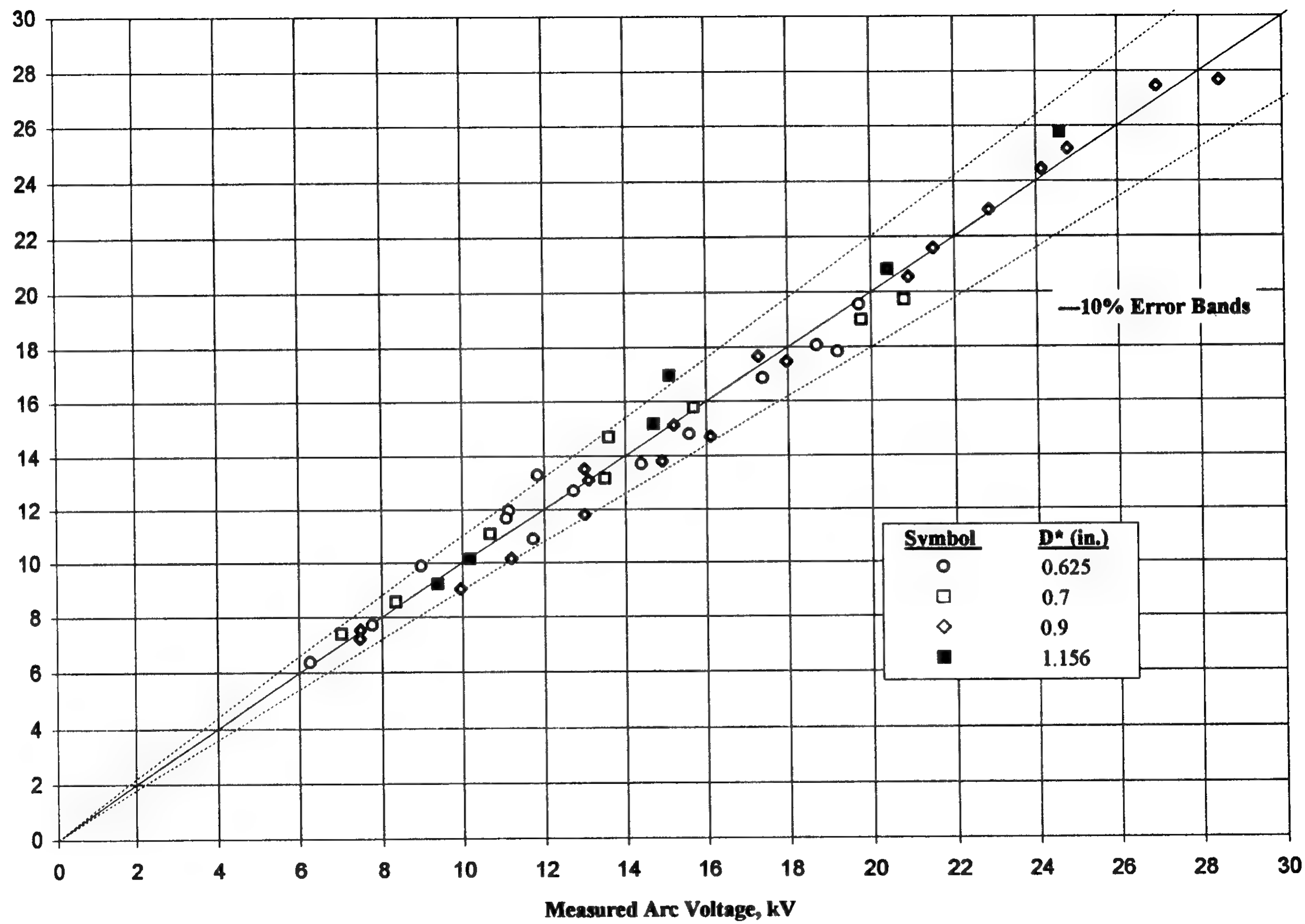

Figure 5. Calculated versus Measured Arc Voltage for the H1 Data Base for Various Throat Diameters (D*).

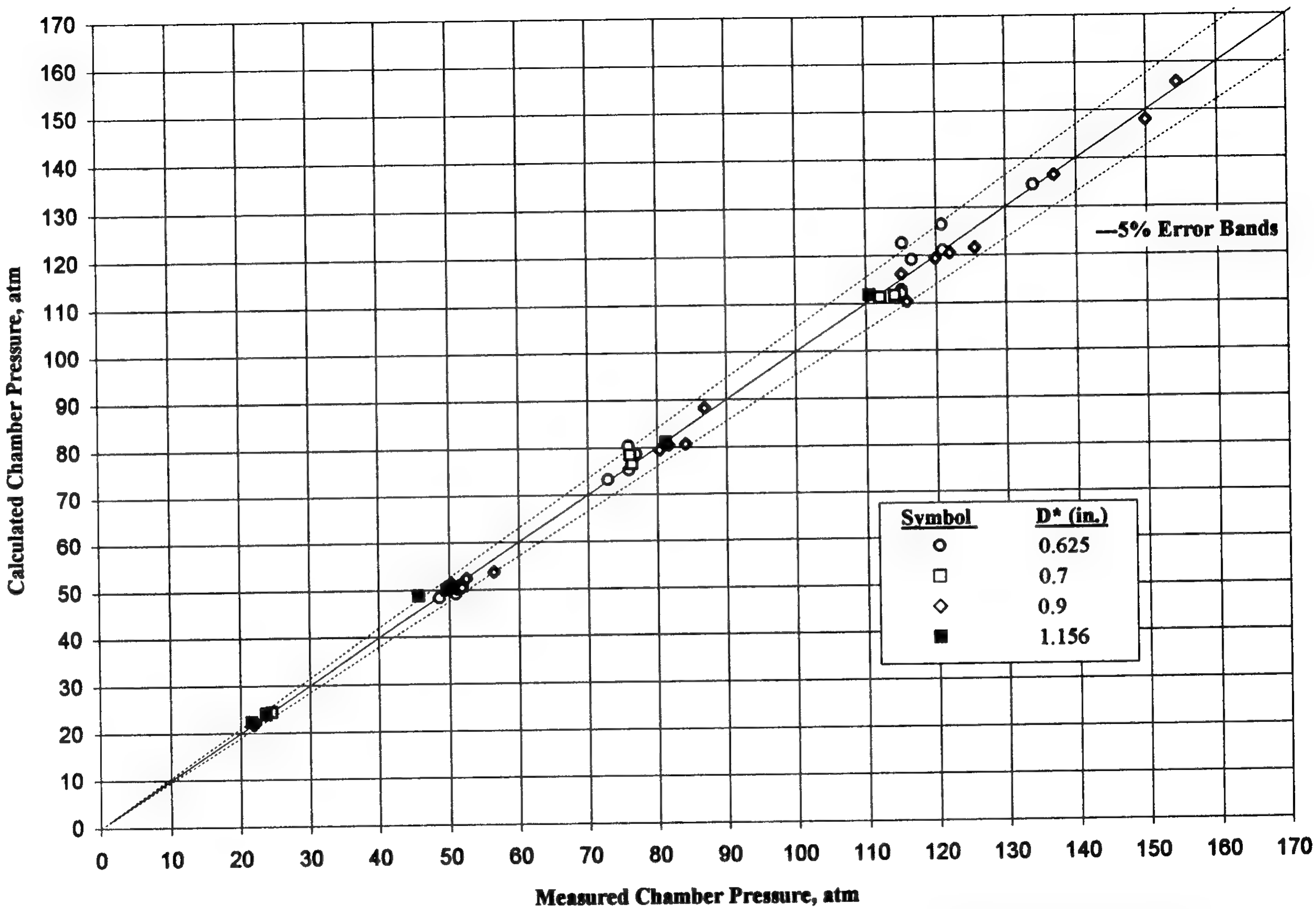

Figure 6. Calculated versus Measured Chamber Pressure for the H1 Data Base for Various Throat Diameters (D*).

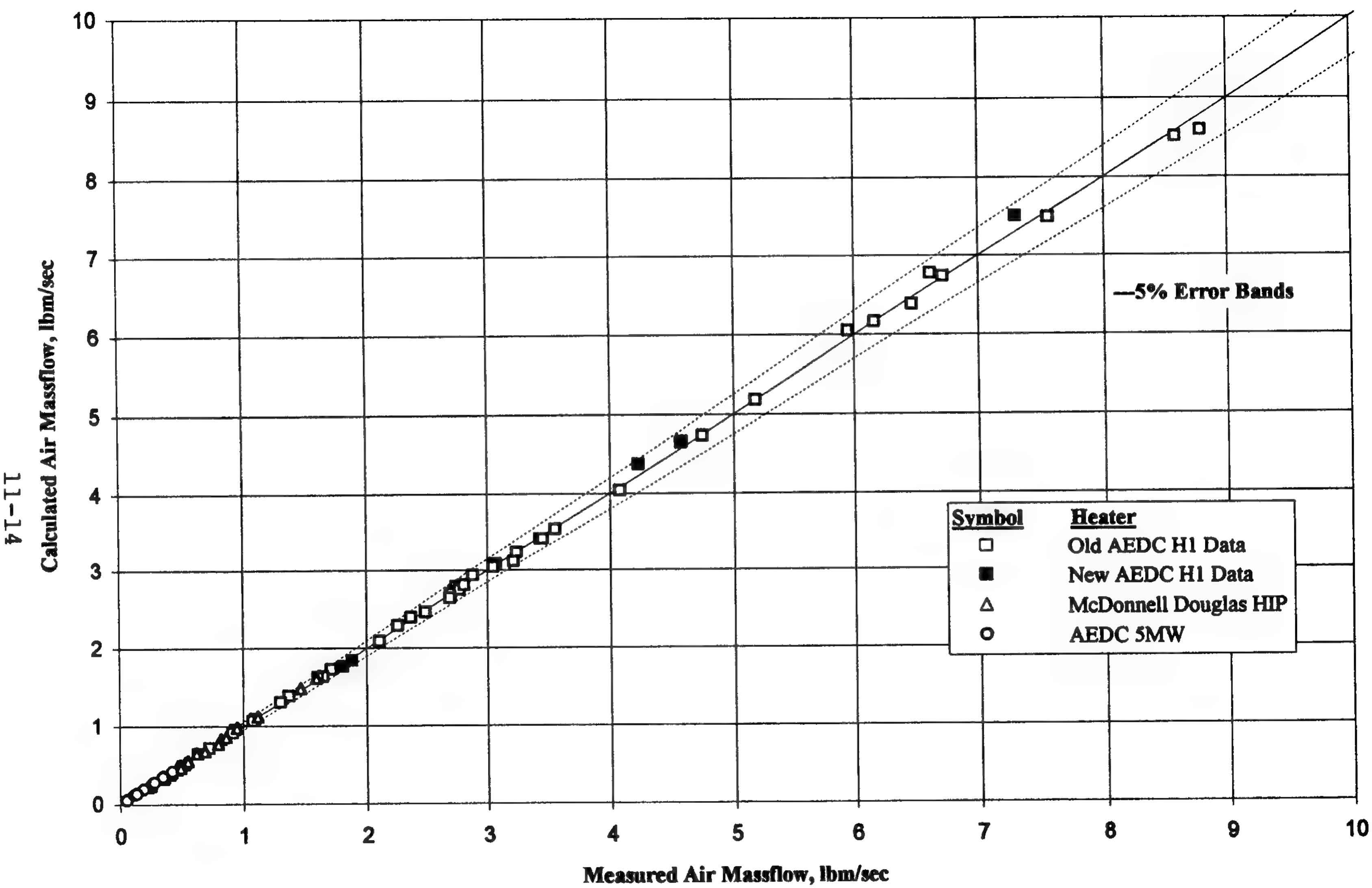

Figure 7. Calculated versus Measured Equilibrium Sonic Mass Flow for the Combined Data Base.

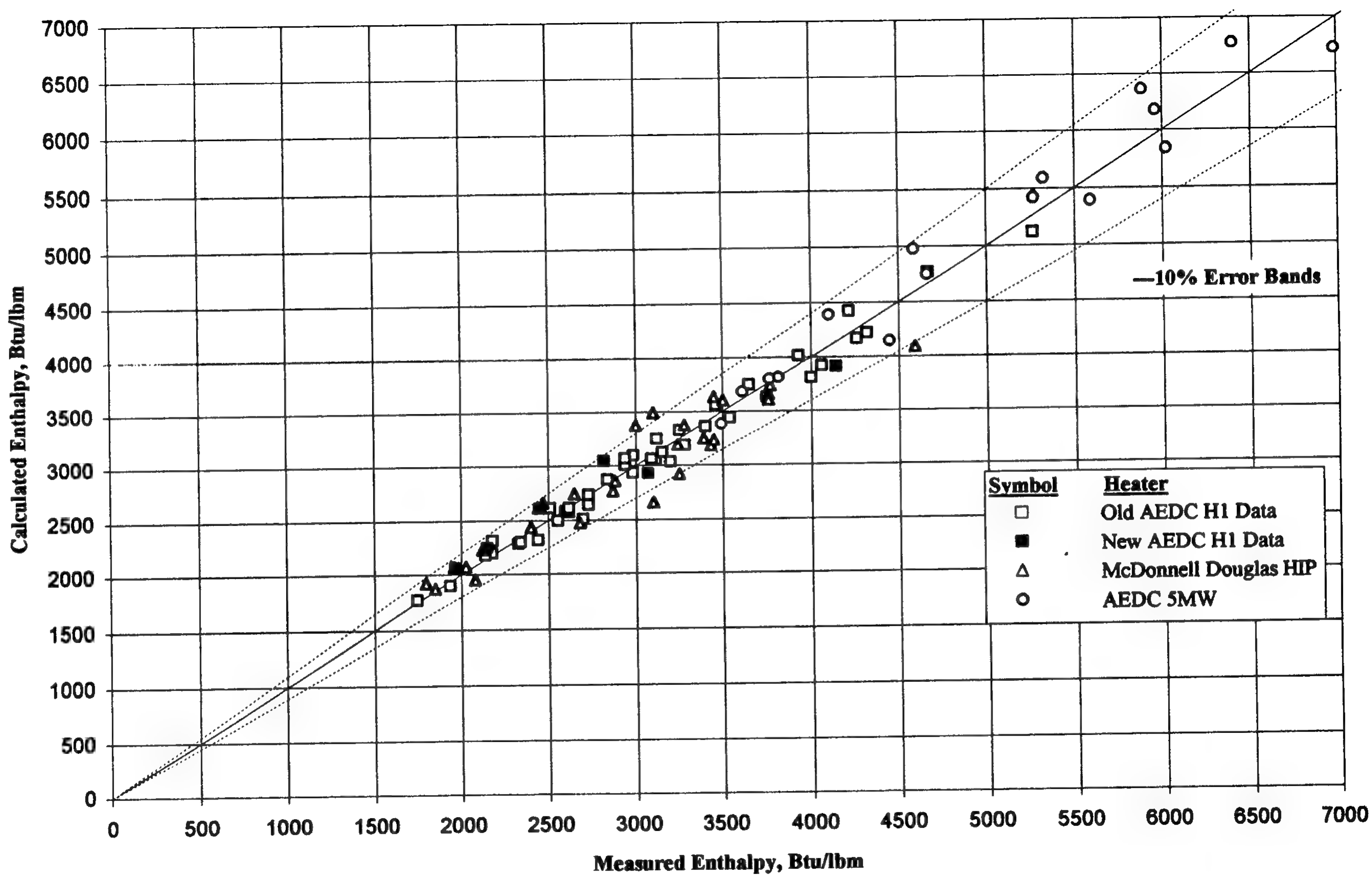

Figure 8. Calculated versus Measured Equilibrium Sonic Flow Enthalpy for the Combined Data Base.

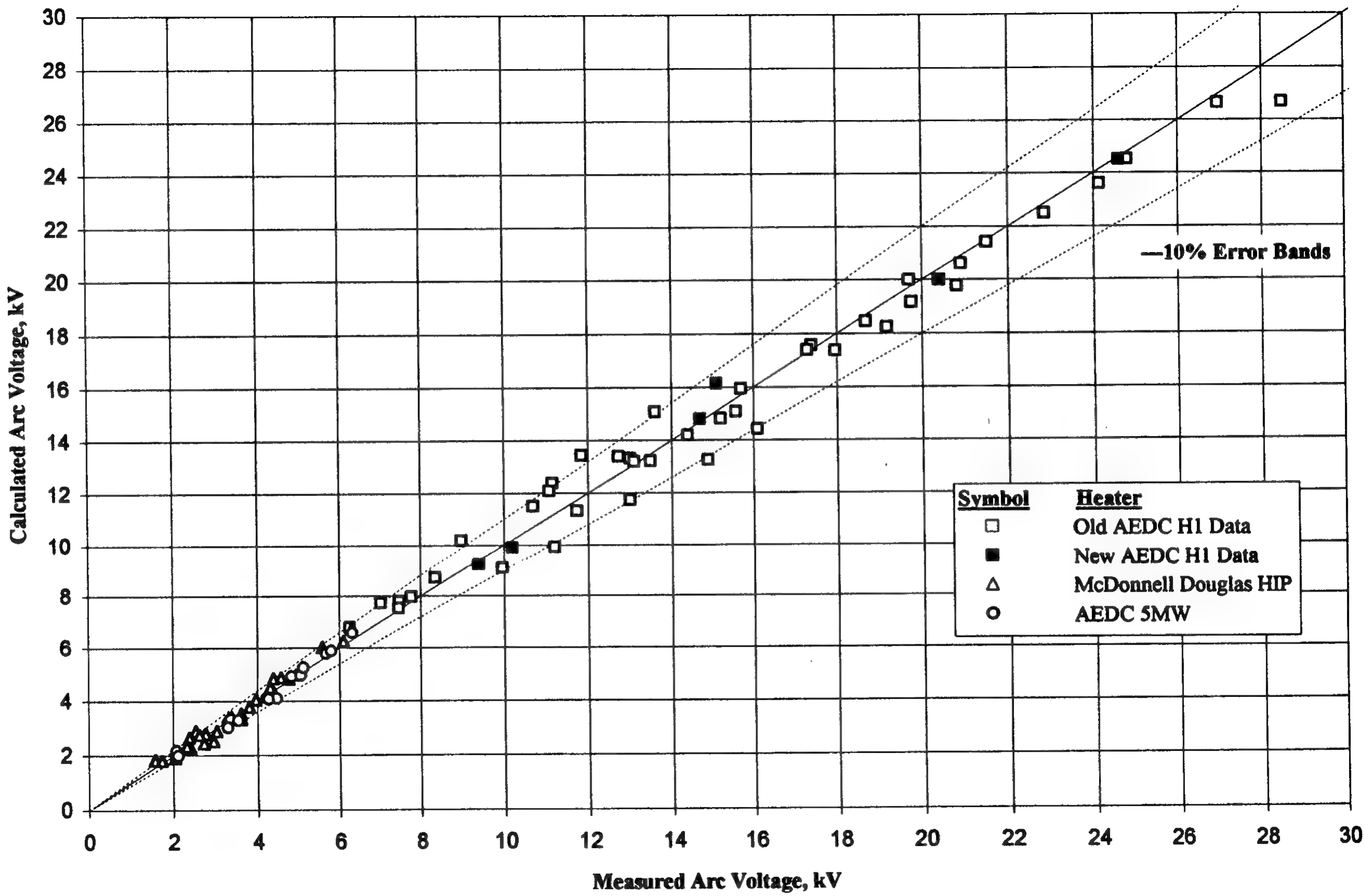

Figure 9. Calculated versus Measured Arc Voltage for the Combined Data Base.

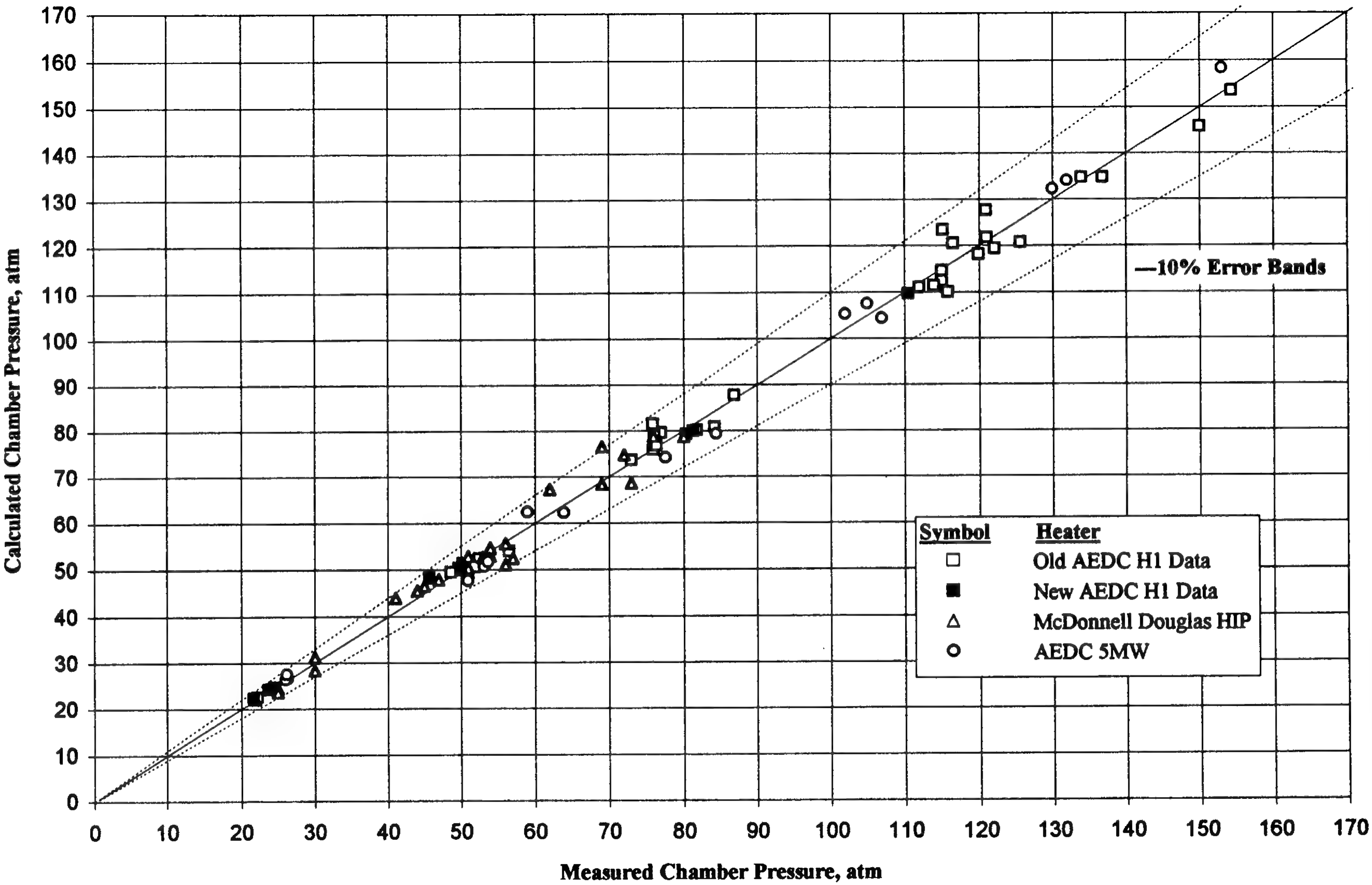

Figure 10. Calculated versus Measured Chamber Pressure for the Combined Data Base.

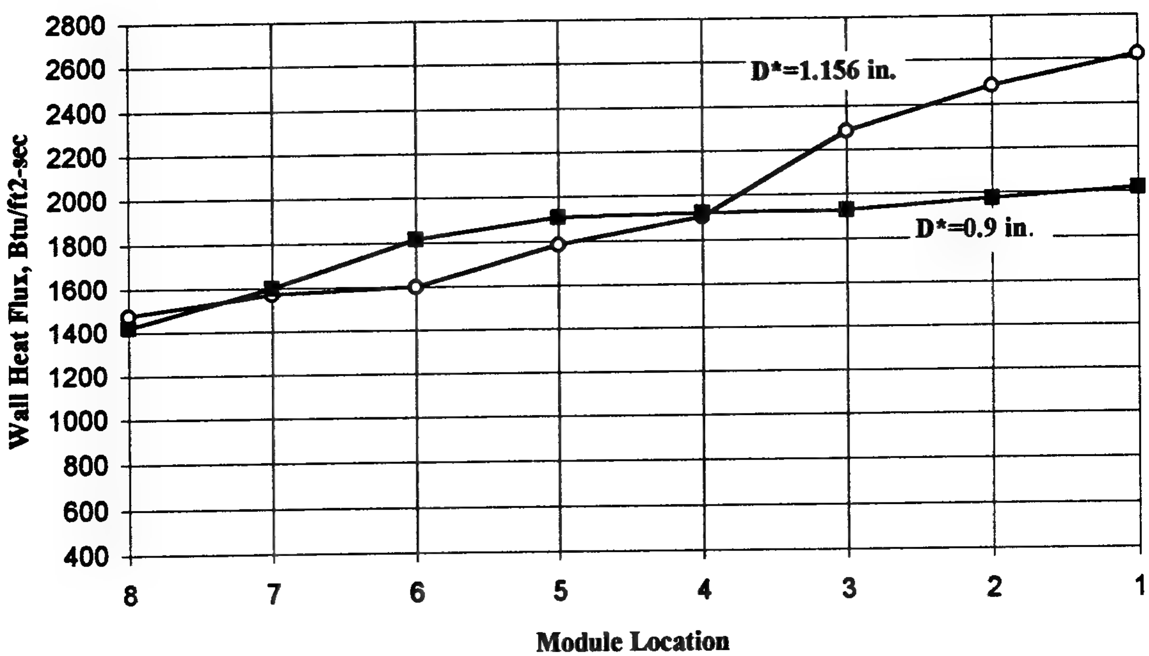

Figure 11a. Comparison of the Effect of Throat Diameter on Wall Heat Flux at Similar Operating Conditions.

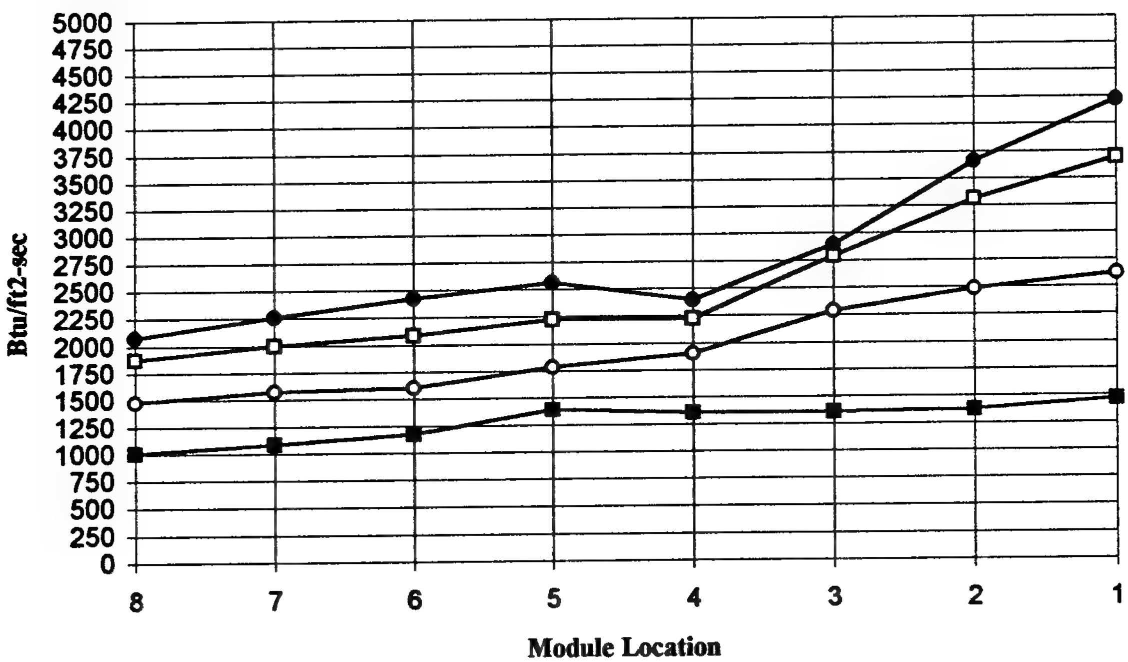

Figure 11b. Module Wall Heat Flux: Comparison of Similar Large Throat Diameter Runs in terms of Air Mass Flow Rate.

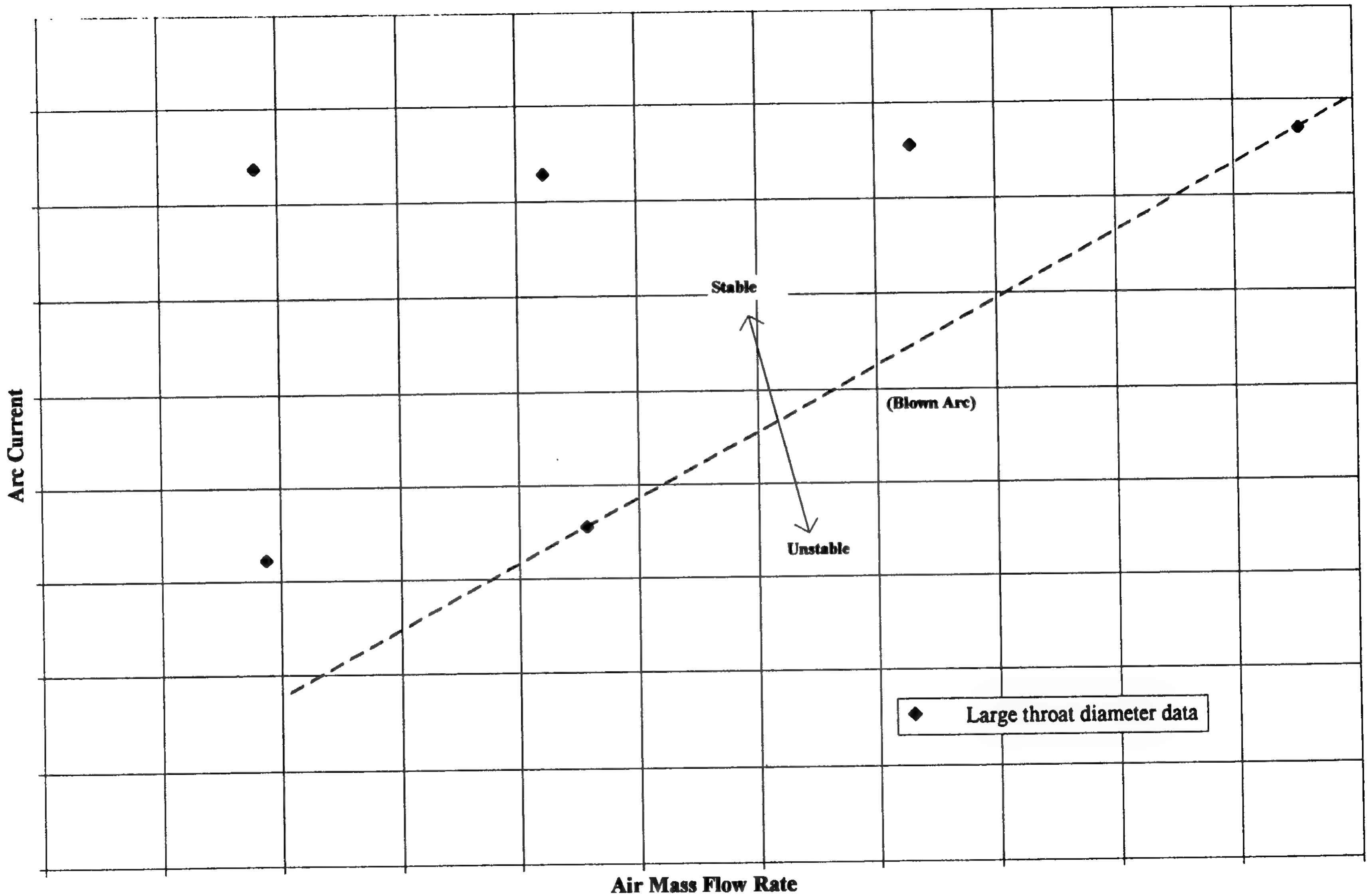

Figure 12. Operational Stability: Arc Current Plotted as a Function of Air Mass Flow Rate.

Maintenance of Facilities

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Final Report for:
High School Apprentice Program
Arnold Engineering and Development Center

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Arnold Engineering and Development Center

August 1997

Maintenance of Facilities

Daniel M. Thompson
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Abstract

The predictive and preventive maintenance program of Arnold Engineering and Development Center was studied. To a certain extent, it was re-organized, so that the maintenance schedule was made more accurate. The database program *Microsoft Access* was used to temporarily store and edit the large amounts of data from previous maintenance records.

Maintenance of Facilities

Daniel M. Thompson

Introduction

For several years, the maintenance program at AEDC was stored on a large database known as Computer Automated Preventive Maintenance System (CAPS). The program was difficult to use, and required certain personnel in order to edit or enter data. In order to make the information more accessible and user-friendly, the maintenance branch of AEDC has resolved to switch to a different system known as Computerized Maintenance Management System (CMMS). The data stored in CAPS has been temporarily imported to *Microsoft Access* in preparation for the conversion; most of the information contained in this report was established using Access. The data recorded aids personnel in determining whether it is more cost-effective to replace the component or execute the needed maintenance. The first problem identified was a deficiency in organization in the data contained in the CAPS. The information was difficult to process, and required special paper to be printed on. Using Access made the re-organizing and re-structuring of the data feasible. The second problem was the lack of accuracy in some of the information, such as the predicted man-hours and the facility number. Determining the correct number of man-hours is important in scheduling preventive maintenance, to make sure all the essential procedures are being performed, and to eliminate unnecessary ones.

Figure 1.1 displays a typical maintenance procedure and a comparison between the standard estimated man-hours and AEDC estimated man-hours. In this example, AEDC craftsmen were scheduled to perform maintenance for four hours every month, when it should have taken only one and one-half hours annually. This deficiency in scheduling not only costs time, but money as well.

Standard Procedure	Standard Man-hours	AEDC Man-hours	Standard	AEDC Frequency
HOIST WINCHES	1.5	4	12	1

Figure 1.1 Standard VS. AEDC

Methodology

Access was used primarily to clean up inaccurate information imported from the CAPS system. The table shown in figure 1.2 is a part of the records of the maintenance procedures prior to clean-up. Figure 1.3 represents the same data after clean-up.

Procedure Parag	Procedure	Freq	Procedure Description
3.2	4003008	3	THREE-WIRE GRND ELEC HAND TOOLS
3.2.1	4003008	3	( ) PERFORM GRNDNG CHECK
3.2.2	4003008	3	( ) CHK PWR PLUG/CORD/HOUSNG FOR DAMAGE
3.2.3	4003008	3	( ) CLEAN EXTRIOR/INTRIOR SURFACES-IF REQD
3.1	4003008	12	DOUBLE INSLTD ELEC HAND TOOLS
3.1.1	4003008	12	( ) VIS CHK PLUG/CORD/HOUSING FOR DAMAGE
3.1.2	4003008	12	( ) CLEAN EXTERIOR/INTERIOR SURFACES IF
3.1.2A	4003008	12	-REQD***DO NOT USE CHLORINE***
3.1.3	4003008	12	( ) PERFORM 500V INSULATION TEST
3.1.4	4003008	12	( ) CHK CONSTANT PRESS SWITCH
3.3	4003008	12	POWDER ACTUATED HAND TOOLS
3.3.1	4003008	12	( ) DISASMBLE-CLN-OIL NECESSARY PARTS RE-
3.3.2	4003008	12	( ) CHK BREECHING PARTS FOR DEBRIS-CLN
3.3.3	4003008	12	( ) CHK-MUZZLE END OF TOOL FOR PROTECTIV
3.3.3A	4003008	12	-SHIELDS/GUARDS/JIGS/FIXTURES
3.4	4003008	12	PNEUMATIC HAND TOOLS
3.4.1	4003008	12	( ) CHK/CLN/REPAIR PER MANFCTRS MANUALS

Figure 1.2 Before cleanup

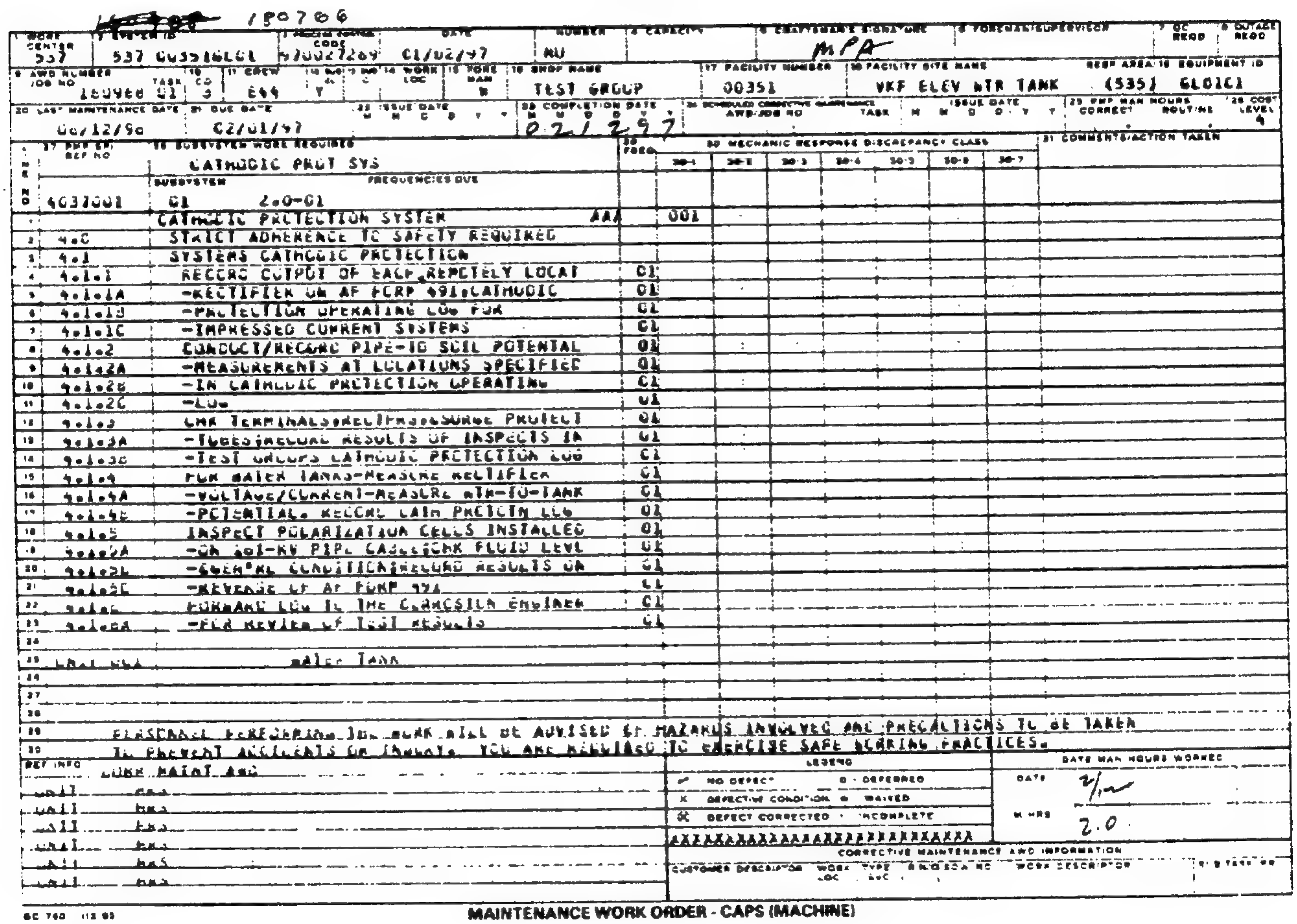
Procedure Parag	Procedure	Freq	Procedure Description
3.2	4003008	3	THREE-WIRE GROUND ELECTRICAL HAND TOOLS
3.2.1	4003008	3	( ) PERFORM GROUNDING CHECK
3.2.2	4003008	3	( ) CHECK POWER PLUG - CORD - HOUSING FOR
3.2.3	4003008	3	( ) CLEAN EXTERIOR - INTRIOR SURFACES IF REQUIRED
3.1	4003008	12	DOUBLE INSULATED ELECTRICAL HAND TOOLS
3.1.1	4003008	12	( ) VISUALLY CHECK PLUG - CORD - HOUSING FOR
3.1.2	4003008	12	( ) CLEAN EXTERIOR & INTERIOR SURFACES IF
3.1.2A	4003008	12	** DO NOT USE CHLORINE **
3.1.3	4003008	12	( ) PERFORM 500V INSULATION TEST
3.1.4	4003008	12	( ) CHECK CONSTANT PRESS SWITCH
3.3	4003008	12	POWDER ACTUATED HAND TOOLS
3.3.1	4003008	12	( ) DISASSEMBLE - CLEAN - OIL NECESSARY PARTS
3.3.2	4003008	12	( ) CHECK BREECHING PARTS FOR DEBRIS & CLEAN
3.3.3	4003008	12	( ) CHECK MUZZLE END OF TOOL FOR PROTECTIVE
3.3.3A	4003008	12	-SHIELDS - GUARDS - JIGS - FIXTURES
3.4	4003008	12	PNEUMATIC HAND TOOLS
3.4.1	4003008	12	( ) CHECK - CLEAN - REPAIR PER MANUFACTOR MANUAL

Figure 1.3 After cleanup

Clean-up was accomplished by manually checking each record for mistakes in punctuation, spelling, and grammar. The second problem, that of inaccuracy in some of the data records, was resolved by matching predicted maintenance man-hours to an industry standard, *Facilities Maintenance and Repair Cost Data.* The number of predicted man-hours was averaged for each work order for the fiscal year of 1997, then that number was compared to the same procedure in *Facilities Maintenance.* In most cases, AEDC overestimated greatly, causing errors in the scheduling of maintenance; the workmen were constantly ahead of or behind schedule. On the average, AEDC overestimated its maintenance procedures by about five hours.

Results

The result is a database system that is easier for the civil engineers to access. The new program allows them to print and edit data from their own desktop computer. The deficiency in scheduling has been corrected to a large extent, and most of the mistakes in grammar have been corrected as well. However, the project was not completed due to the large amount of information stored in the system. Figure 1.4 shows a work-order from the previous CAPS system. Figure 1.5 shows the same work-order from *Access,* similar to that of CMMS.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CATHODIC PROT SYS

4637001 01 2.0-01

CATHODIC PROTECTION SYSTEM AAA 001

4.0 STRICT ADHERENCE TO SAFETY REQUIRED

4.1 SYSTEMS CATHODIC PROTECTION

4.1.1 RECORD OUTPUT OF EACH REPETELY LOCAT 01

4.1.1A -RECTIFIER ON AF FORM 491,CATHODIC 01

4.1.1B -PROTECTION OPERATING LOG FOR 01

4.1.1C -IMPRESSED CURRENT SYSTEMS 01

4.1.2 CONDUCT/RECORD PIPE-TO SOIL POTENTAL 01

4.1.2A -MEASUREMENTS AT LOCATIONS SPECIFIED 01

4.1.2B -IN CATHODIC PROTECTION OPERATING 01

4.1.2C -LOG 01

4.1.3 CHK TERMINALS,RECTIFRS,&SURGE PROTECT 01

4.1.3A -TUBES,RECORD RESULTS OF INSPECTS IN 01

4.1.3B -TEST GROUPS CATHODIC PROTECTION LOG 01

4.1.4 FOR WATER TANKS-MEASURE RECTIFIER 01

4.1.4A -VOLTAGE/CURRENT-MEASURE WTR-TO-TANK 01

4.1.4B -POTENTIAL, RECORD CATH PROTCTN LOG 01

4.1.5 INSPECT POLARIZATION CELLS INSTALLED 01

4.1.5A -ON 101-KV PIPE CASE,CHK FLUID LEVEL 01

4.1.5B -GENERAL CONDITION,RECORD RESULTS ON 01

4.1.5C -REVERSE OF AF FORM 491 01

4.1.6 FORWARD LOG TO THE CORROSION ENGINEER 01

4.1.6A -FOR REVIEW OF TEST RESULTS 01

WATER TANK

PERSONNEL PERFORMING THE WORK WILL BE ADVISED OF HAZARDS INVOLVED AND PRECAUTIONS TO BE TAKEN TO PREVENT ACCIDENTS OR INJURY. YOU ARE REQUIRED TO EXERCISE SAFE WORKING PRACTICES.

2/12

2.0

MAINTENANCE WORK ORDER - CAPS (MACHINE)

Figure 1.4 CAPS Work Order

ACS RELIABILITY CENTERED MAINTENANCE WORK ORDER

Charge No: ______ Work Order: ______ WO Number: 193 Sel ✓

System # 351GL01 Lead Org E44 Supt Org 1: ___ Supt Org 2: ___ Last Maint 10/2/95

Month Due 7 Year 1997 Description CATHODIC PROT SYS

Freq 1 Procedure 4037001

Facility 351 Facility Name POTABLE WATER STORAGE TANK

Eq Code GL Eq Description CATHODIC PROTECTION

Unit Records

001 AAA WATER TANK

Sys Procedures Outage ☐ Closed Area ☐

AAA	1	Monthly	4.1	SYSTEMS CATHODIC PROTECTION
AAA	1	Monthly	4.1.1	( ) RECORD OUTPUT OF EACH REMOTELY LOCATED RECTIFIER ON AF FORM 491. CATHODIC
AAA	1	Monthly	4.1.1A	PROTECTION OPERATING LOG FOR IMPRESSED CURRENT SYSTEMS
AAA	1	Monthly	4.1.2	( ) CONDUCT / RECORD PIPE-TO SOIL POTENTIAL MEASUREMENTS AT LOCATION SPECIFIED
AAA	1	Monthly	4.1.2A	IN CATHODIC PROTECTION OPERATING LOG
AAA	1	Monthly	4.1.3	( ) CHECK TERMINALS,RECTFRS,& SURGE PROTECT TUBES; RECORD RESULTS OF
AAA	1	Monthly	4.1.3A	INSPECTIONS IN TEST GROUPS CATHODIC PROTECTION LOG
AAA	1	Monthly	4.1.4	( ) FOR WATER TANKS-MEASURE RECTIFIER VOLTAGE / CURRENT - MEASURE WATER-TO-
AAA	1	Monthly	4.1.4A	TANK POTENTIAL. RECORD IN CATHODE PROTECTION LOG
AAA	1	Monthly	4.1.5	( ) INSPECT POLARIZATION CELLS INSTALLED ON 161-KV PIPE CABLE; CHECK FLUID LEVEL &
AAA	1	Monthly	4.1.5A	GENERAL CONDITION; RECORD RESULTS ON REVERSE OF AF FORM 491
AAA	1	Monthly	4.1.6	( ) FORWARD LOG TO THE CORROSION ENGINEER FOR REVIEW OF TEST RESULTS

Lead Org Craftsmen ______ Lead Org Manhours Used ______

Supt Org 1 Craftsmen ______ Supt Org 1 Manhours Used ______

Supt Org 2 Craftsmen ______ Supt Org 2 Manhours Used ______

Lead Org Craft Supervisor ______ Date Completed ______

Remarks, Comments, Derogatory Statements

Instructions

1. Locate component designator in the unit record block (ex. AAA, AAB, GGG ...)
   Note: Not all unit records will have work to be done on them
2. Locate same component designator in the procedure block, this is the work to be done on the associated unit
3. Check off unit when complete
4. Check off procedure items when all units complete
5. Fill in action taken information required on work order
6. Note any comments or corrective action over 30 minutes required
7. Fill in the time required to do job and sign.
   Note: Time required is number of craft times time at job
8. Return completed work order to Jim Holloway

Contact Jerry Bailey, x3884 or Sys Engr SILVER ______ Phone ______ for any PM questions or modifications

Figure 1.5 *Access* Work-Order

Conclusion

The implementation of the CMMS database program will make the maintenance information more accessible to the civil engineers of ACS. Because of the difficulties installing CMMS, and the time needed clean and re-organize the data taken from CAPS, *Access* will be used as the primary database for several more years. The project was not completed, due to the large amounts of data contained in the system that required editing.

References

1. Bailey, Jerry "ACS Reliability Centered Maintenance Program", briefing given at Arnold Engineering and Development Center, June 1997.

2. Bailey, Jerry "ACS Reliability Centered Maintenance Plan", briefing given at Arnold Engineering and Development Center, 16 October 1996.

3. Mossman, Melville J. ed. *R.S. Means Facilities Maintenance and Repair Cost Data.* R.S. Means Co., Inc, Kingston, 1996.

ACCESS CONVERSIONS

James R. Williamson

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Winchester, TN 37398

Final Report for:
High School Apprentice Program
Arnold Engineering and Development Center

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Arnold Engineering and Development Center

August 1997

ACCESS CONVERSIONS

James R. Williamson
Franklin County High School

Abstract

AEDC runs an automated inventory tool to maintain an accurate description of its networked PS's. This tool plays an integral role in the Year 2000 effort, which is tasked with determining the compliance status of each PC as well as its software. The inventory tool, Norton Administrator, collects the required data and stores it in a proprietary database. Other Year 2000 specific data was stored in a Microsoft Access 7.0 database. It was necessary to merge the two files into a single database to provide on-going reporting and status data. My task was the merging of these files and the development of associated queries, forms, and reports.

ACCESS CONVERSIONS

James R. Williamson

Introduction

With the year 2000 and the imminent computer failure being less than three years away, it becomes continually more imperative to make sure that all the computers on base are Year 2000 compliant. Norton Administrator was used to inventory all the computers on the network. The information gathered from the inventory will be used in compliance research and results. ACS needed all of this data in Microsoft Access 7.0 format, so someone had to type in a few hundred pages of information. They needed a faster and easier way.

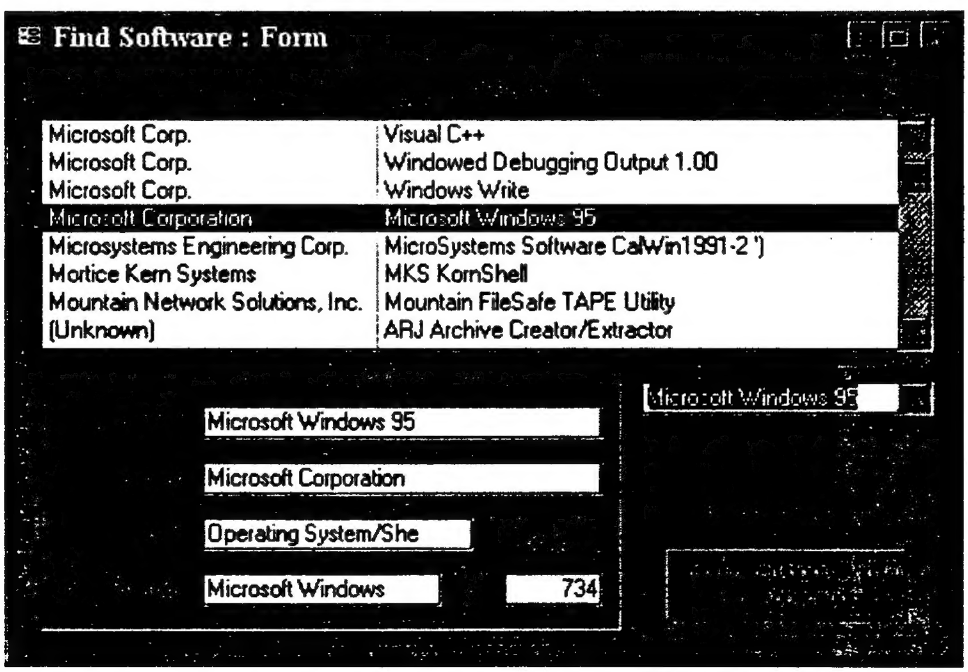
Problems

There were many problems I had to face. First of all, I not only couldn't export the Norton table directly to Access format but I couldn't directly import it either. Secondly, not everyone enters data in a consistent format.

Methodology

In order to get all the data from Norton Administrator into Microsoft Access, I first exported all the fields we needed to dBase III format since it was recognized by both Norton and Access. Then I imported the data into Access and stored it in its own table. In order to uniquely identify each computer, they are assigned machine names. These names were to be of the format "AF0#####" (where a # is any integer). Most of them were like this, but some were very different, having names such as "af038274", "036475", "74629", and even "HALF-BAKED". I wrote a query that would look through the table, try to figure out what the name was supposed to be, and then rename it. For names like "af038274", all it had to do was capitalize "af", for "036475" and "74629" it just added "AF" or "AF0". For the others, someone would

have to look at them and decide what to call them. That problem solved, the next step was to update the existing table from the new one. First I wrote a query that looked through both tables and found matching machine names. If it found one then it would go ahead and replace the old record with the new data. If it didn't find a matching entry, it would make a new one. When it had finished it would spit out a list of all the records it couldn't figure out. This list usually has about nine or ten records on it which have to be entered by hand. Much less than the two thousand which had to be typed in before. After making sure all the computers were compliant, the next step was to make sure all the software was too. Norton Administrator also runs an inventory on all the computers and keeps track of all the software on the network. We needed all of this information in Access too. I got it there the same way I did before, and then I created the following form to display all of the software titles and all the information about them. With this form we could tell at a glance who published the application, what kind of application it was, which platform it ran on, and how many copies of it there were. With the click of a button, we got a list of everybody who had it and where it was on their computer. We could then call the publisher to find out if the application was Year 2000 compliant and then notify the users if it wasn't.



Results

I provided an automated reconciliation of the two databases, which automated processes that were formerly a mixture of manual and automated activities. Increased efficiency in productivity and manual research was the result of these activities. Additionally, another result was a single, centralized database of all PC information, a first for the Center. These efforts will provide an on-going source of information for the Year 2000 project over the next several years.